AUBURN RAVINE

A. Water Quality Data

1. Lincoln High School Water Quality Monitoring: Mark Fowler and Lee Beckman provided data from the Lincoln High School sampling program, which is jointly funded by NID, Placer County, and the City of Lincoln. While the data are limited, two parameters are of concern from a stream ecology standpoint. First, the dissolved oxygen concentrations reported show supersaturated levels of approximately 150%, which is unusual for lower gradient streams. Second, the concentrations of nitrate reported for Highway 193 and Joiner Parkway sites are high for a fall reading and could indicate eutrophication of the stream, particularly during the summer months. Without data on orthophospate for comparison, it is not possible to determine if nitrates are limiting biostimulation of algal growth and potentially causing diurnal dissolved oxygen fluctuations during the nighttime hours. **Source: Lincoln High School Sampling Program, unpublished data.**

Table 1. Auburn Ravine Water Quality Data 2001-2

Parameter	Mackenroth Property	Highway 193 Bridge	Joiner Parkway Bridge
Date	9/21/2002	10/7/2002	9/23/2001
Time	1000	1128	1045
Air Temperature (^{O}F)	67	--	--
Water Temperature (^{O}F)	60	65	62
Weather	Clear	Clear	Clear
Stream Flow (cfs)	7.7	1.5	1.5
pH	7.7	7.7	7.16
Dissolved Oxygen (mg/l)	13.4	13.4	16.5
Electrical Conductivity (µs/cm)	152.9	56.4	71.7
Color (color units)	42	1	8.5
Nitrates (mg/l)	0.7	1.1	1.90
Chlorides (mg/l)	0.04	0.07	0.02
Total Coliform (MPN/100ml)	240	290	290
Fecal Coliform (MPN/100ml)	460	93	75

2. Auburn Ravine/Coon Creek Ecosystem Restoration Plan: This plan, published by the County of Placer, contains preliminary data on heavy metals and a number of other constituents. The data were collected on Auburn Ravine, Coon Creek, and in the Eastside Canal (the actual sampling location is actually just upstream of the Cross Canal, even though the data location is labeled Cross Canal). The County is already in possession of these data in electronic format and the data are not re-presented, except for data on cadmium, copper, and zinc, which are presented in Appendix Auburn Ravine 1 because all of these metals at some times of the year exceed California Toxic Rule objectives for aquatic life. In Auburn Ravine, the only metal that exceeds the standards at 50 mg/l hardness is copper. The other metals are included because their standards are exceeded in other streams in the western portion of the County. Based on these

data, the ratio between orthophosphate and a combination of dissolved nitrite and nitrate appears to be reasonable and should not cause excessive algal blooms at this downstream location. **Source: California Toxics Rule and Department of Water Resources unpublished data.**

3. 1992 City of Auburn Wastewater Treatment and Disposal Master Plan DEIR: Table 3-2 in DEIR displays summary data from three stations. These stations are Clark Ranch at Bridge Lane (upstream of Fowler Road), Brewer Road crossing, and Catlett Road crossing in Sutter County. Four or five samples (Bridge Lane only) were taken during August-September of 1987, with no specific dates given. Table 2 displays the pertinent average summary data. In general, the water quality parameters measured fall within an expected and acceptable range for anadromous fish streams. Appendix E in the DEIR includes a complete set of data for the U.S. EPA priority pollutant scan required for NPDES permit renewal. Review of this data did not indicate any problems with pesticide concentrations, and the heavy metals analysis shows no readings that exceed California Toxic Rule standards. **Source: 1992 City of Auburn Wastewater Treatment and Disposal Master Plan DEIR; R.E. Beck. 1987. "A Preliminary Report on Fishery Viability of Auburn Ravine Creek, Placer County, California", from Department of Fish and Game files, Region 2.**

Table 2. Mean values of selected water quality constituents from three locations along Auburn Ravine from samples collected during Aug.-Sep. 1987.

Constituent	Clark Ranch Bridge Lane	Brewer Road Crossing	Catlett Road Crossing
Number of samples	5	4	4
Turbidity	None	V. Slight	Milky
Temperature	64	67	68
pH	7.0	7.3	7.3
Ammonia Nitrogen	0.6 mg/l	0.4 mg/l	0.8 mg/l
Dissolved Oxygen	10 mg/l	10 mg/l	6 mg/l
Carbon Dioxide	5 mg/l	5 mg/l	26 mg/l
Total Acidity	9 mg/l	10 mg/l	36 mg/l
Total Alkalinity	23 mg/l	65 mg/l	150 mg/l
Hardness	34 mg/l	77 mg/l	155 mg/l

Source: 1992 City of Auburn Wastewater Treatment and Disposal Master Plan DEIR; R.E. Beck. 1987. "A Preliminary Report on Fishery Viability of Auburn Ravine Creek, Placer County, California", from Department of Fish and Game files, Region 2.

4. 1997 City of Auburn FEIR Auburn Wastewater Facility Plan: This FEIR contains data on a variety of water quality parameters measured on Auburn Ravine sources. These measurements include a U.S. EPA priority pollutant scan for pesticides and heavy metals. Data on heavy metals concentrations are presented in Table 3-10 of the FEIR. These data show no metals at concentrations of concern for the protection of aquatic life in Auburn Ravine upstream of the discharge. No data is presented for areas immediately downstream of the discharge location. Table 3-11 in the FEIR also shows some water quality data for six stations downstream of Lincoln (Table 3-11 in the FEIR indicates that station L7 is upstream of the City of Lincoln, but Figure 1 in Appendix E of the FEIR shows station L7 downstream of the City. The data in Table 3-11 do show one area of concern, the range of pH values over the sampling period at the

"lower reach" of 5.95-7.4. The low value of 5.95 is of concern because of its potential effects on aquatic life. Also of concern is the range of values recorded over a relatively short "summer" time period. Appendix Auburn Ravine 2 of this report is adapted from Table 3-9 in the FEIR and displays sampling results during 1995 at two locations, one upstream of the discharge location (R-1) and one immediately downstream of the discharge in the mixing zone (R-4). These data show pH values fluctuating from 5.7 to 7.4 over the course of two months. This pattern is consistent with that observed in other nearby watersheds. Appendix B of this report also shows that water temperatures and dissolved oxygen levels are suitable for spawning and rearing of anadromous fish species on a year around basis. **Source**: **1997 City of Auburn FEIR Auburn Wastewater Facility Plan.**

5. 1996 City of Auburn, Draft Auburn Wastewater Treatment Plant Stream Study: At public request, this study was conducted to assess the impacts of treatment plant expansion on the aquatic ecosystem of Auburn Ravine. This report contains much more detail on the water quality information summarized in the 1997 City of Auburn FEIR Auburn Wastewater Facility Plan mentioned directly above. **Source: 1996 City of Auburn, Draft Auburn Wastewater Treatment Plant Stream Study.**

6. 1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility: This DEIR was prepared to support a new wastewater treatment and reclamation facility to meet growing demand within the City of Lincoln and possibly serve as a future site for a regional wastewater treatment facility which could receive effluent from Placer County's SMD #1 Plant on Joeger Road and currently a major dry weather supplier of flow to Dry/Coon Creek, the City of Auburn's Wastewater Treatment Plant located on Auburn Ravine just downstream of the City of Auburn, and effluent from Newcastle and development projects like the Bickford Ranch Project. Appendix C of this DEIR contains a variety of water quality information associated with sample taken from Auburn Ravine in 1995 and includes a U.S. EPA priority pollutant scan. These data show no identified problems with pesticides, although some metals (e.g., copper) are near or exceed California Toxics Rule standards for some samples. Appendix A in the DEIR displays the results of the Department of Water Resources sampling during 2001 near Catlett Road in Sutter County. Copper concentration exceeded California Toxic Rule standards on three occasions during the year. Copper concentrations are a concern, but exceed the standards only occasionally and appear to be of natural origin. It is likely that the local organisms have adapted to these chronic levels over time. . **Source: 1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility.**

7. 11/3/1984 Biological Survey by David Vanicek, Sacramento State University, at the Otto Residence, just upstream of Ophir: This was a fish sampling survey, but Vanicek did report a pH of 7.3; dissolved oxygen concentration was 9.0 mg/l; and a conductivity of 195 umhos/cm. **Source: Vanicek report in Department of Fish and Game files, Region 2.**

B. <u>Water Temperature Data</u>

Water temperature data were extracted from various one-time fish sampling projects conducted by the CDFG and are presented below. Most of the data comes from monitoring conducted by Bailey Environmental and includes hourly readings. Due to limitations in the statistical package,

only 3,000 temperature data points can be displayed in a single time series plot. Since daily maximum, minimum, and/or mean temperatures individually are of little value, all data points have been plotted for three time periods that correspond to:

Fall-early winter: September though December; primary fall-run chinook salmon spawning period is November-December.
Winter-spring: January though April; fall-run chinook salmon incubation and rearing and steelhead spawning, incubation, and rearing.
Late spring-summer: May to September; summer rearing for steelhead juveniles.

Data plots for these time periods are presented below to allow the reader to assess the potential of Auburn Ravine to support chinook salmon and/or steelhead trout spawning and rearing. A variety of localized data and literature was reviewed, to provide a generalized understanding of the temperature effects on various life history stages for both chinook salmon and steelhead trout. There is fairly substantial variation in temperature effects noted for most life history stages. However, both chinook salmon and steelhead have a highly adaptable physiology and ability to seek thermal refuge during part of the day, which allows them to tolerate and/or avoid lethal temperatures. Some of the literature sources cite criteria from others and some of the data is based on fish captures with water temperature taken concurrently. Two tables with data and reference are included in Appendix B of this report. Based on this review, the following criteria have been used to indicate what life history stages a particular stream may support at any given time:

Chinook Salmon	**^{O}C**	**Steelhead Trout**	**^{O}C**
Egg and fry development	14.4 (58 ^{O}F)	Egg and fry development	14.4 (58 ^{O}F)
Juvenile rearing	21.1 (70 ^{O}F)	Juvenile rearing	22.2 (72 ^{O}F)
Adult migration	21.7 (71 ^{O}F)	Adult migration and holding	22.2 (72 ^{O}F)

Reference lines for 14.4 ^{O}C and 22.2 ^{O}C have been provided on Figures 1 through 11, below to approximately represent the water temperatures suitable for salmonid spawning migration, egg and fry development, and juvenile rearing.

1. 3/3/59 One-time Electrofishing Survey Near Goldhill Road Crossing: This survey reported a water temperature of 54.5 ^{O}F and air temperature of 74 ^{O}F at 1500 hours on this date. Stream flow was estimated at 10 cfs. **Source: Unidentified author memorandum in CDFG, Region 2 files.**

2. 8/27/71 One-time Electrofishing Survey: Water temperature was reported as 68 ^{O}F on this date with no time or location given, but the author did state that there was commercial land use adjacent to the site. I speculate that this site was within the City of Lincoln. Source: **Unidentified author memorandum in CDFG, Region 2 files.**

3. 11/3/1984 Biological Survey by David Vanicek, Sacramento State University, at the Otto Residence, just upstream of Ophir: This was a fish sampling survey, but Vanicek did report a water temperature of 14 ^{O}C (57 ^{O}F) at an estimated flow of 15 cfs, with no time of

measurement given. **Source: Vanicek report in Department of Fish and Game files, Region 2.**

4. 1984 seining and electrofishing for native brood year 1983 fall-run chinook salmon.

Date	Time	Water Temp. (^{O}F)	Location
2/28/84	--	52	Fowler Road
2/28/84	1100	52	Moore Road
5/2/84	--	52	Fowler Road

Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.

5. Moore Road Juvenile Trapping Survey May 9-17, 1992: This data is from a short-term juvenile chinook salmon trapping program on Auburn Ravine. The trapping location was located approximately ½ mile upstream of the Dowd Road extension on the Moore Ranch. I speculate that this site was very near the Moore Road crossing. **Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.**

Juvenile Trapping Survey May 9-17, 1992.

Date	Time	Water Temp. (^{O}F)	Location
5/10/92	1015	60	100 yards downstream of Dowd Rd.
5/11/92	0620	59	100 yards downstream of Dowd Rd.
5/12/92	0700	58	100 yards downstream of Dowd Rd.
5/13/92	0800	59	100 yards downstream of Dowd Rd.
5/14/92	1900	58	100 yards downstream of Dowd Rd.
5/15/92	0700	58	100 yards downstream of Dowd Rd.
5/16/92	0715	58	100 yards downstream of Dowd Rd.

Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.

6. 1995 Monitoring Results from the1996 City of Auburn, Draft Auburn Wastewater Treatment Plant Stream Study: Water temperature data from this study is presented in Appendix B of this report. These data show that the mean monthly maximum water temperature at station R-1, just upstream of the discharge location did not exceed 15.9 ^{O}C during the year. This indicates that this upper portion of Auburn Ravine is suitable for anadromous fish spawning and rearing on a year around basis. Daily water temperature (and certain water quality parameters) were monitored on a 15-minute basis over the period October 4-November 3, 1995. Daily mean values are presented in Tables 6A and 6B and Figure 3 of Attachment 3 in this report. **Source: 1996 City of Auburn, Draft Auburn Wastewater Treatment Plant Stream Study.**

7. Water Temperature Information From Bailey Environmental April 1999 To August 2003: This study begun by the City of Lincoln in April 1999 to provide some baseline information for their EIR on a new wastewater treatment and reclamation facility. Stations were established at Fowler Road, the Nevada Irrigation District gaging station near Highway 65 in Lincoln, just downstream of Nelson Lane, Moore Road, just downstream of Moore Road on the Moore Ranch (identified as Bitter's Property), and on the Aitken Ranch approximately 1 mile

downstream of the Moore Ranch station. Because of continued vandalism problems, the Moore Road station was discontinued in 2000. Although City support for these stations ended in 2001, Bailey Environmental has maintained the data collection since then. All of the stations have suffered some data anomalies (e.g., sensors becoming buried in the sand and recording only the temperature in the sand and not daily fluctuations or someone taking the sensor out of the water). In some instances data are missing completely because of theft or sensor failure. There are some 150,000 readings from these locations. In May 2003, Placer County contracted to add additional stations on Auburn Ravine. Stations were added at the Otto Residence near the town of Ophir in the upper watershed and at the Davis Ranch Bridge off Catlett Road in Sutter County. All of the data for all of the stations has been delivered to the County in electronic format.

For this report, I have provided the current time series for the new stations (Otto and Davis Ranch Bridge; Figures 1 and 2, respectfully) and selected one-year's (Sept. 2002 to Aug 2003) data for three stations (Fowler Road (Figures 3-5), NID gaging station (Figures 6-8), Bitter's Property (Figures 9-11) to demonstrate approximate temperature regimes at each location.
Source: Bailey Environmental, unpublished data.

Figure 1. Water temperature time series for Auburn Ravine at the Otto property, upstream of the Lozanos Road Bridge, during the period June 5 through August 4 2003. This data indicates that this area of Auburn Ravine was suitable for juvenile salmonid rearing during the warmest summer period.

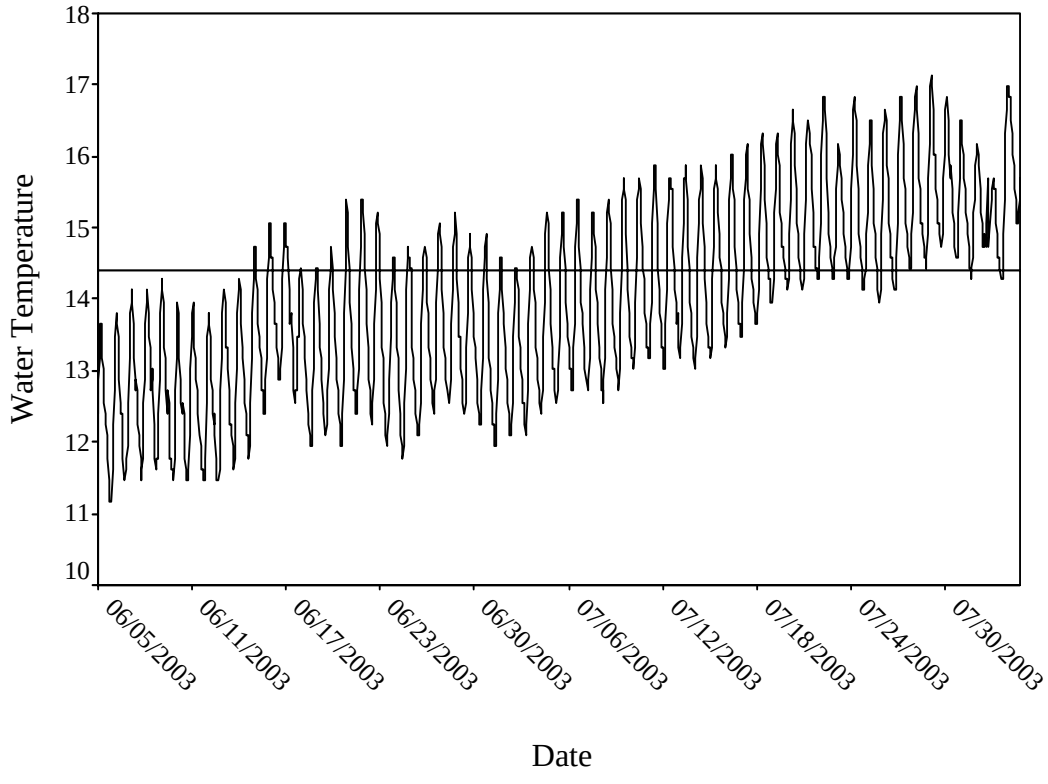


Figure 2. Water temperature time series for Auburn Ravine at the Davis Ranch Bridge in Sutter County, during the period May 28 through August 4 2003. This data indicates that this area of Auburn Ravine was unsuitable for juvenile salmonid rearing during the warmest summer period.

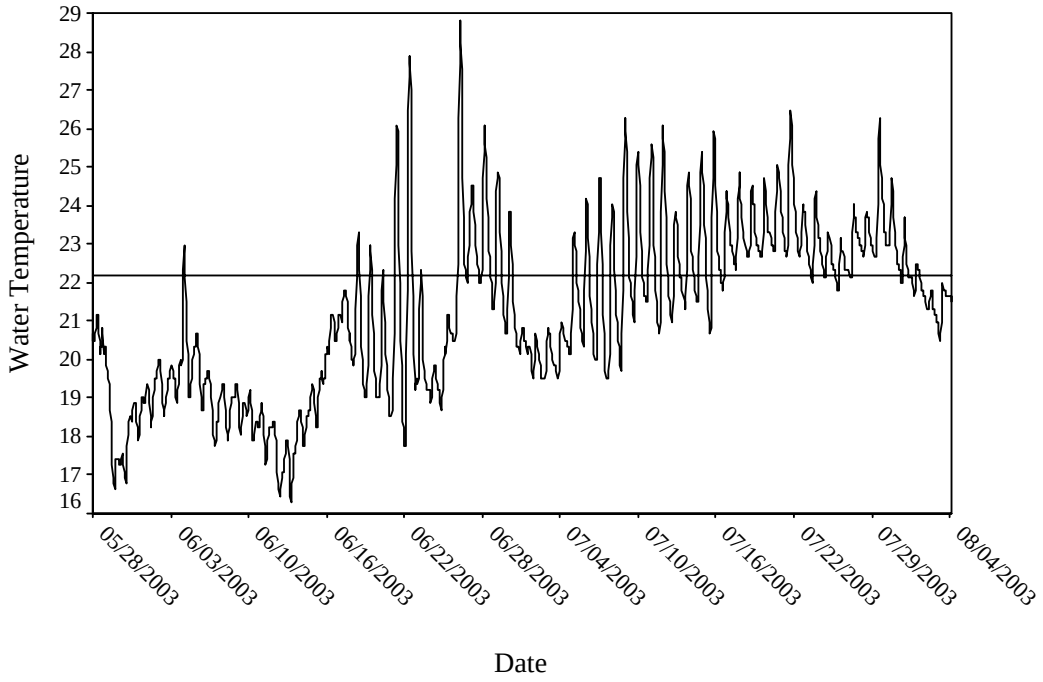


Figure 3. Water temperature time series for Auburn Ravine at the Fowler Road property, during the period September through October 22, 2002 (electronic data from October 22, 2002 to January 29, 2003 was lost). Successful fall-run chinook salmon spawning could have commenced in mid to late October and conditions were suitable for juvenile rearing.

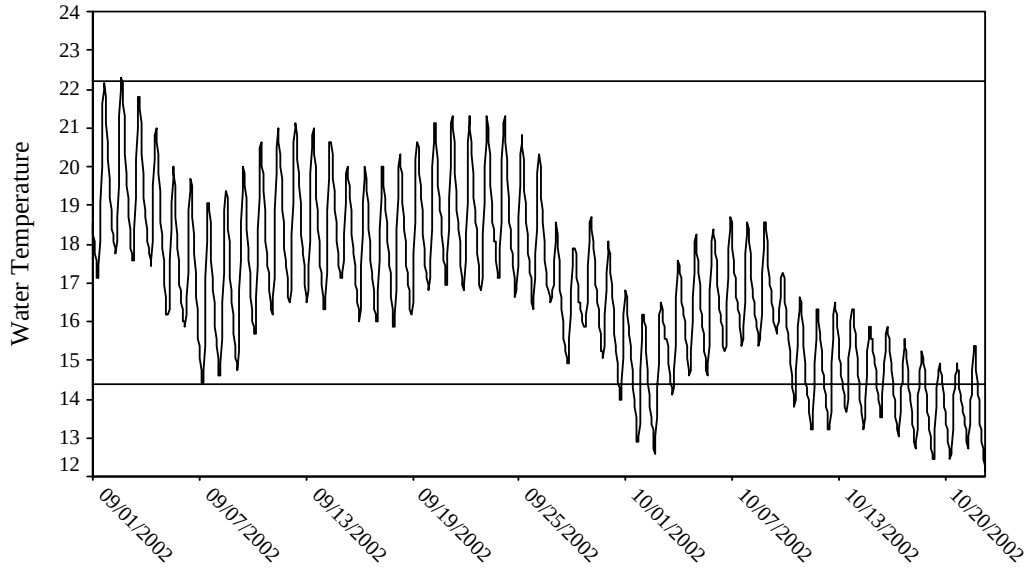


Figure 4. Water temperature time series for Auburn Ravine at the Fowler Road property, during the period January through April 2003. Temperatures are suitable for egg incubation and juvenile rearing.

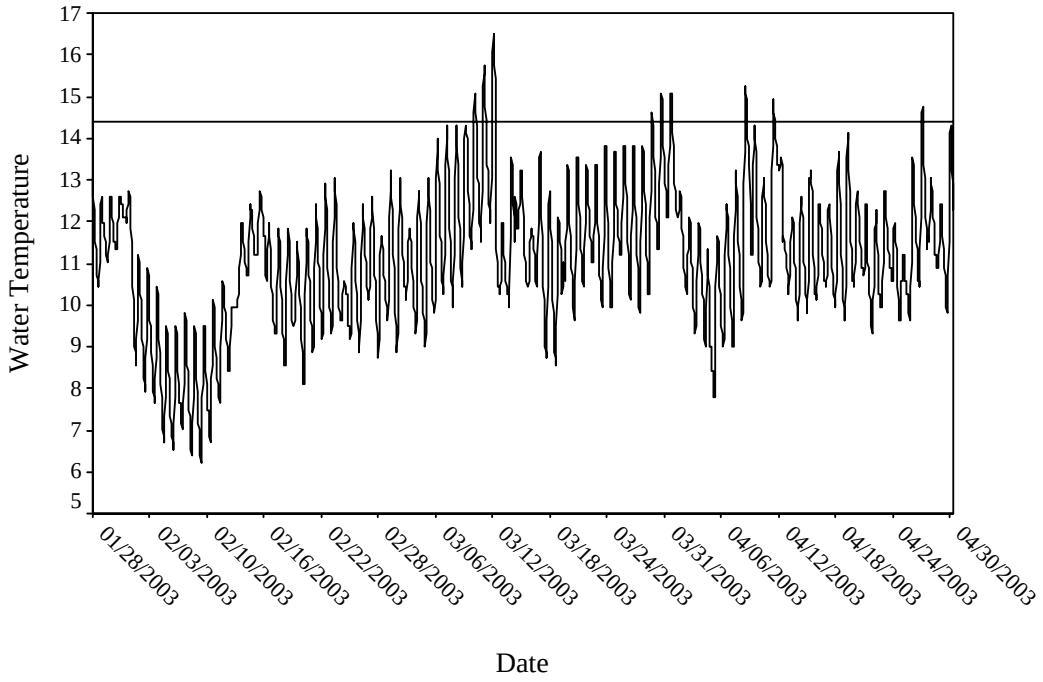


Figure 5. Water temperature time series for Auburn Ravine at the Fowler Road property, during the period May through August 4, 2003. Temperatures are suitable for juvenile rearing. Note the sensor became buried in sand during the latter portion of this time period.

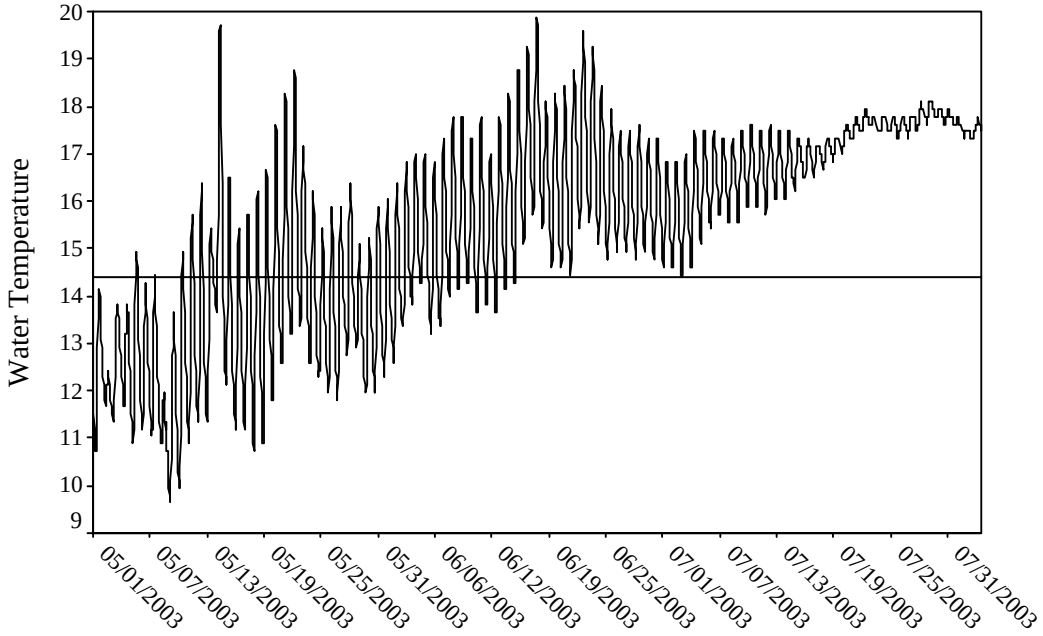


Figure 6. Water temperature time series for Auburn Ravine at the NID gaging station, during the period September 9 through December 2002. Successful fall-run chinook salmon spawning could have commenced in mid to late October. It appears that the sensor may have become buried in the substrate in mid-December.

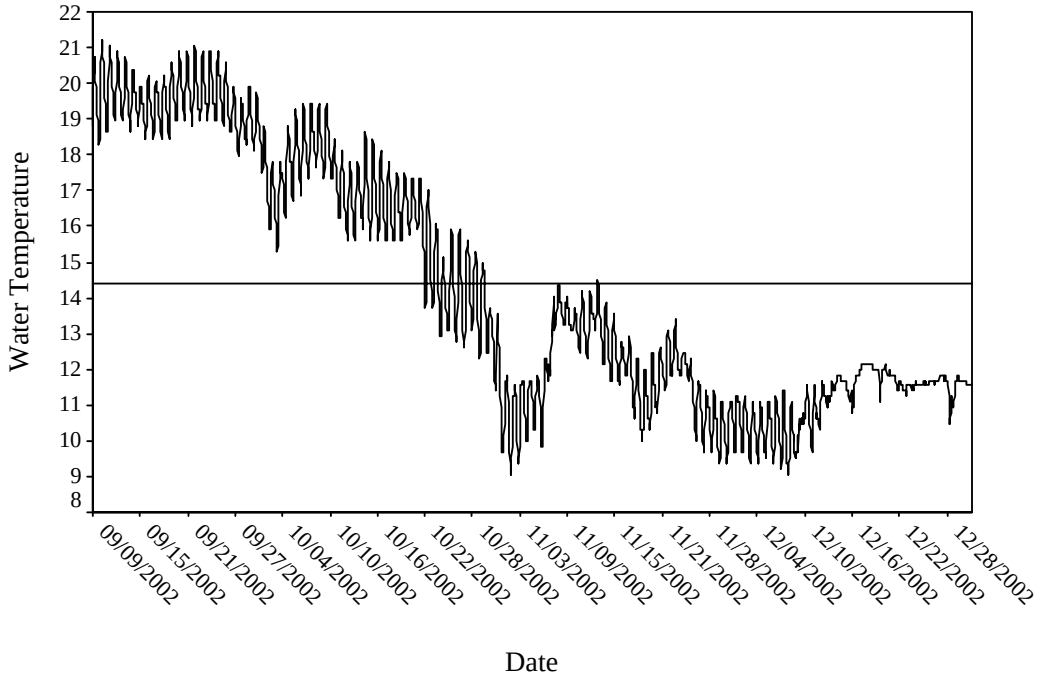


Figure 7. Water temperature time series for Auburn Ravine at the NID gaging station, during the period January through April 2003. Temperatures are suitable for egg incubation and juvenile rearing. The sensor was buried in the substrate until January 29, 2003.

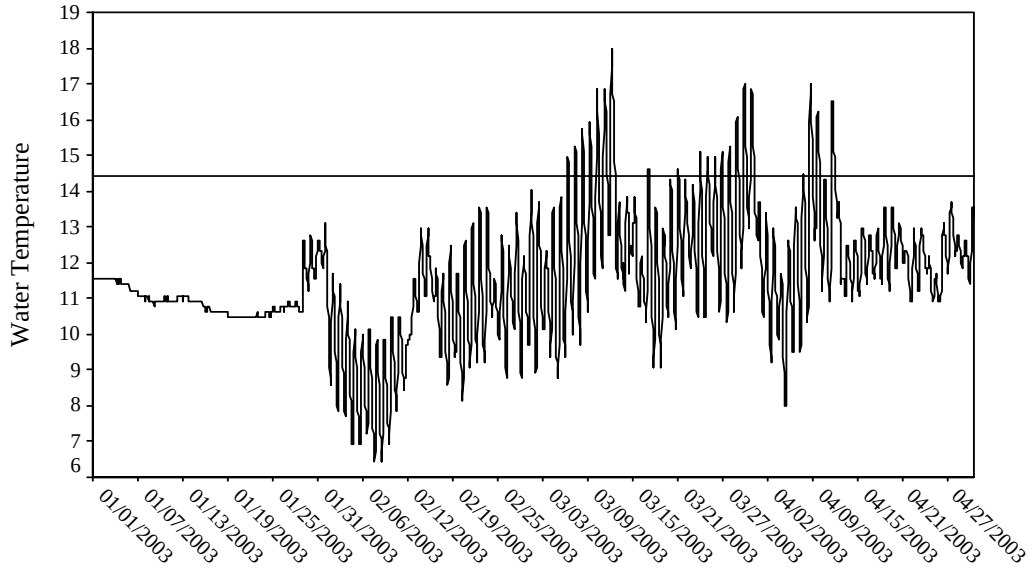


Figure 8. Water temperature time series for Auburn Ravine at the NID gaging station, during the period May through August 5 2003. Temperatures are suitable for juvenile rearing. Note the sensor became buried in sand during the latter portion of this time period.

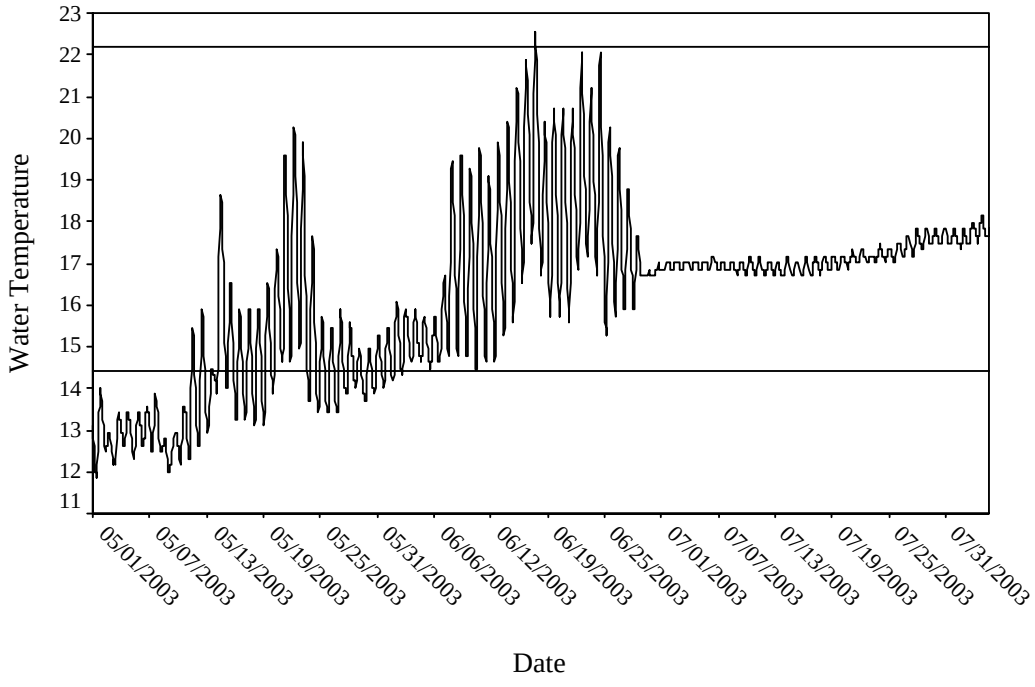


Figure 9. Water temperature time series for Auburn Ravine at the Bitters property, during the period September through October 22, 2002 (electronic data from October 22, 2002 to January 29, 2003 was lost). Successful fall-run chinook salmon spawning could have commenced in late October. However this station contains no spawning gravels and is several miles downstream of suitable spawning habitat.

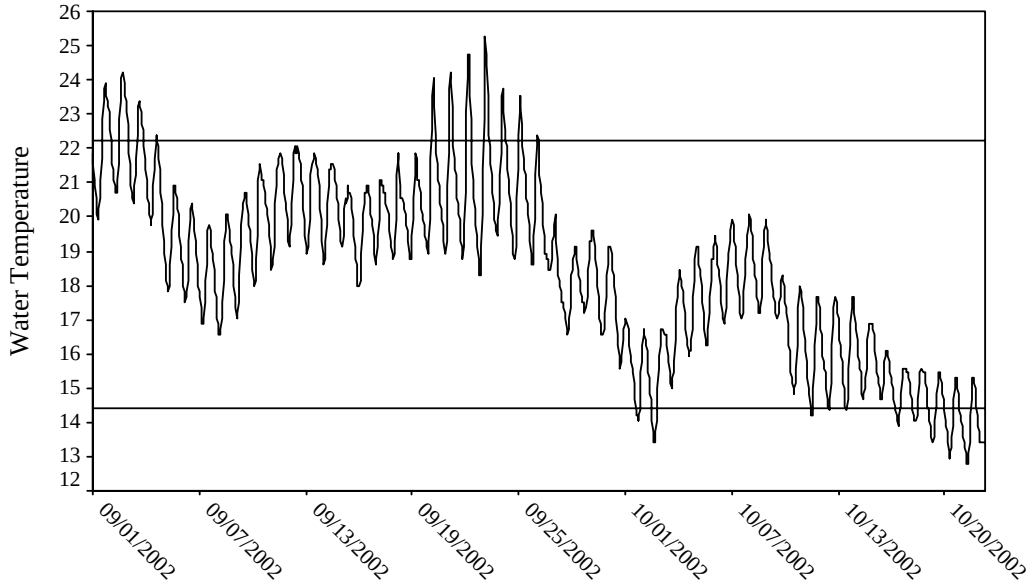


Figure 10. Water temperature time series for Auburn Ravine at the Bitter's property, during the period January 28, 2003 through April 2003. Temperatures are suitable for egg incubation and juvenile rearing.

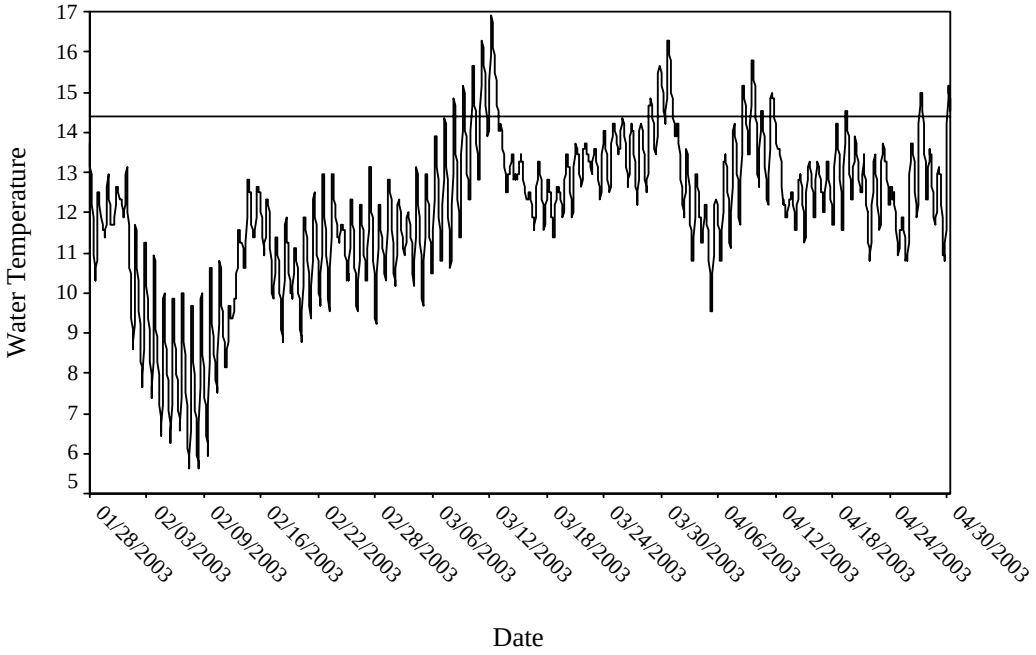
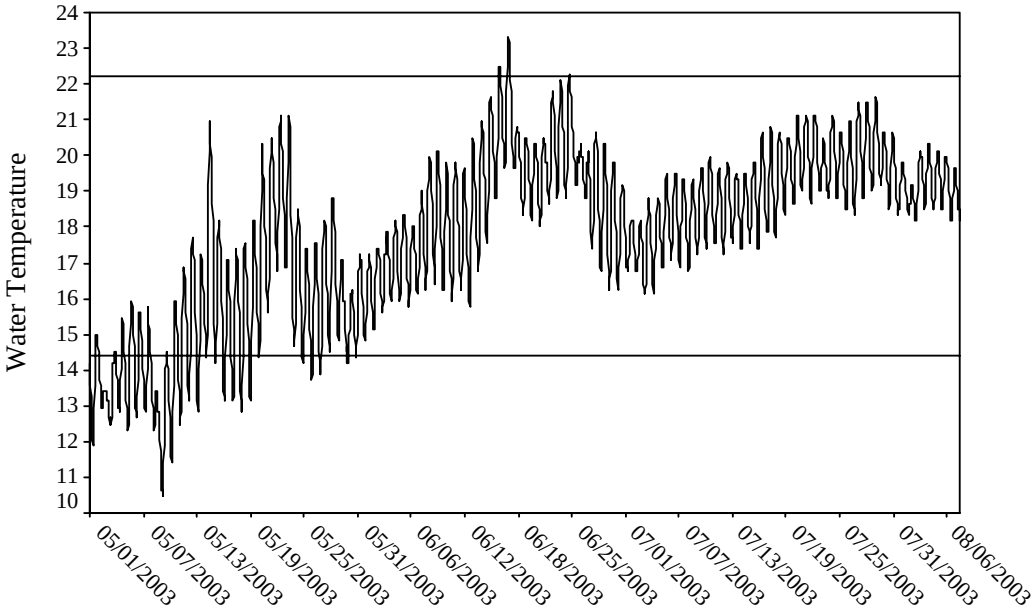


Figure 11. Water temperature time series for Auburn Ravine, Bitter's property, during the period May through August 8 2003. Temperatures are suitable for juvenile rearing.



The water temperature data from the Bailey Environmental study suggest that water temperatures are adequate to support salmonid spawning, egg incubation, and rearing in a number of locations

in Auburn Ravine, although there are unsuitable conditions at Davis Ranch Bridge. The loss of some data due to apparent burying of sensors in sediment points out the problem of high sediment input to Auburn Ravine in many locations.

C. Benthic Invertebrate Data

Three separate sampling programs or projects have sampled benthic macroinvertebrates from various reaches of Auburn Ravine. These sampling efforts are described below:

1. Citizen Monitoring by the Auburn Ravine Group: Samples were collected at Moore Road and Joiner Parkway in March 200 and at Joiner Parkway in September 2001 (complete data for these three events is presented in Appendix Auburn Ravine 3). Additional samples have been collected more recently, but the analysis results will not be available until early 2004. Data from this sampling is affected by equipment limitations and sampling strategy. First, the equipment used to take the samples does not sample all of the taxa in the stream effectively. Second, taxonomic identification is limited to a maximum of 100 individuals from all taxa, but five of the 10 individual samples collected from the three sampling times and locations contain less than 55 individuals, with two samples containing less than 6 individual organisms. Such low number of individuals in a sample is highly unusual and may indicate severe pollution or habitat problems within the stream. **Source: Benthic Macroinvertebrates sampled from Placer County Streams. Prepared for the Auburn Ravine Group by BioAssessment Services, Folsom, CA., December 2002.**

2. 1997 FEIR Auburn Wastewater Facility Plan: Appendix G of this FEIR summarizes benthic macroinvertebrate sampling that occurred in the fall of 1995 and spring of 1996 in six stream reaches ranging from where Interstate 80 crosses Auburn Ravine, downstream to a reach that includes about 1500 feet of channel downstream of the Lozanos Road Bridge. Table 4 and Figures 9 and 10 in this appendix summarize the results of the fall 1995 sampling. More detailed information on all of the sampling is presented in Attachment 2 of the Draft Auburn Wastewater Treatment Plant Stream Study, August 1996. Results are somewhat mixed, but the Department of Fish and Game concluded that for at least one of the sampling periods, some impairment of benthic macroinvertebrates was noted downstream of the discharge; the FEIR did not find impairment. **Source: 1997 FEIR Auburn Wastewater Facility Plan; 1996 Draft Auburn Wastewater Treatment Plant Stream Study**

3. 1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility: This DEIR reports the results of sampling that occurred in early November 1997 at six locations ranging from about the Highway 193 Bridge in the City of Lincoln, downstream to a location located on the Aitken Ranch near the confluence with Orchard Creek. Three samples were taken at each site. A summary of results is presented in Chapter 7 of the DEIR, with more detailed results presented in Appendix F.3. Most of these samples were taken in an area of the stream where the channel is mostly sand bottomed, although two of the sampling sites upstream of Highway 65 do show increased taxon diversity. However, the species richness and diversity are much less than what was recorded in the 1995-96 Auburn study upstream. This result would be expected because of the differences in water temperature regime, channel substrate, and level of nutrients in these downstream reaches. This study confirms the poor habitat quality for aquatic

insects important to rearing juvenile salmonids. **Source: 1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility**

D. Physical Habitat Data

1. October 16-19 1995 Physical Habitat Survey Conducted by CH2MHill for the City of Auburn: This survey was conducted as part of a stream study to document some of the conditions in Auburn Ravine to support the CEQA process for the upgrade and expansion of the City of Auburn's Wastewater Treatment Facility. A level 3 Department of Fish and Game protocol was completed on six stream reaches ranging from Interstate 80, downstream to 1,500 feet downstream from the Lozanos Road Bridge. A summary of the data and findings are presented in Table 5 of Attachment 3 of the 1996 Draft Auburn Wastewater Treatment Plant Stream Study. A listing of data parameters recorded is presented below. Photos were taken of some sections and are available from the surveyors. Bailey Environmental has copies of the original data sheets. These data indicate that this area of Auburn Ravine is dominated by riffles/cascades (50+% in each reach) and about 20% pool habitat in each reach. Estimated stream gradient in the various reaches ranges from 2.2 to 3.9%. Only cursory summary information has been developed. Detailed and/or statistical analysis is possible if needed.

Parameters Recorded	Parameters Recorded	Parameters Recorded
Date Sampled	Water Depth at Pool Tail Crest (ft)	Left Stream Bank Soil Composition
Habitat Unit Number	Dominant Substrate Size	Right Stream Bank Soil Composition
Habitat Type	Subdominant Substrate Size	Left Stream Bank Vegetation Composition
Side Channel Habitat Type	Shelter Rating	Right Stream Bank Vegetation Composition
Mean Length of Habitat Unit (ft.)	Percent Shelter Type in Habitat Unit	Percent Left Bank Vegetated
Mean Channel Width (ft.)	Percent Total Canopy	Percent Right Bank Vegetated
Mean Water Depth (ft.)	Percent Coniferous Trees	Percent Deciduous Trees
Maximum Water Depth (ft.)		

Source: 1996 Draft Auburn Wastewater Treatment Plant Stream Study; Bailey Environmental, unpublished data from CH2Mhill.

2. 1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility: Appendix F.2 of this DEIR contains all of the information regarding a 3-day survey of Auburn Ravine beginning at the South Sutter Water District diversion on the Aitken Ranch upstream to the Joiner Parkway Bridge in the City of Lincoln. The survey included a cursory assessment of water quality, sediment size and condition, channel structure, and vegetative cover. The survey indicates that shallow runs and glides dominate the channel. The bottom substrate is primarily sand with some coarser gravel. Channel complexity was greatest in areas where riparian vegetation and tree canopy was highest. Several beaver dams, debris dams, and man-made

diversion dam sites were also recorded. **Source: 1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility**

3. 2003 Placer County Spawning Gravel Survey: During the summer of 2003, Placer County funded a survey to examine steelhead trout spawning gravels in this drainage (as well as others). No data are currently available from this effort. However, based on a review of the sampling protocol, it appears that little, if any useful additional information will be obtained.

4. 2003 Placer County Stream Videography Project: On March 12, 2003 this Auburn Ravine was videotaped from the air, beginning the Eastside Canal, upstream to the Wise Powerhouse near Auburn. Review of the video footage shows the riparian area of the stream varies from very poor quality (downstream areas) to very high quality (upstream of Fowler Road). Also, this footage revealed extensive bank erosion that is contributing to the sediment load in the stream. The proportion of the excessive sediment load attributable to bank erosion versus decomposition of underlying rock formations is unknown. Sediment contributions from land disturbing activities and roadways are also unknown. Based on the video footage and field observations over a period of more than 4 years, I consider the area of stream downstream from about the mid-point between Nelson Lane and Jointer Parkway Bridge as only a migratory corridor for anadromous fish. This area is mostly sand bottomed, low gradient channel with little potential for accommodating good quality spawning or rearing habitats for anadromous fish. The area between just downstream of the Joiner Parkway Bridge and locations upstream appears to be suitable for chinook salmon spawning and rearing, with some steelhead rearing also possible in this area. The area upstream of Fowler Road appears to be suitable spawning and rearing area for both chinook salmon and steelhead trout. This upstream area has a higher gradient, less sediment in the gravels, and high levels of desirable habitat complexity than observed in downstream areas.

E. <u>Fishery Resource Data</u>

1. Documented Fish Species Present in the Stream

Redear sunfish
Black bullhead
Bluegill
Largemouth bass
Green sunfish
Mosquitofish
Hardhead
Brown trout
Speckled dace
Prickly sculpin
Pumpkinseed
Golden shiner
Lamprey sp.
California roach
Carp
Rainbow trout/steelhead
Sacramento sucker
Fall chinook salmon (native)
Fall chinook salmon (introduced – Feather River Fish Hatchery)
Fall chinook salmon (introduced – Nimbus Fish Hatchery)
Spring chinook salmon (introduced – Feather River Fish Hatchery)
Sacramento pikeminnow (formerly known as Sacramento squawfish)

Source: California Department of Fish and Game, Region 2 files; 1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility; 1996 Draft Auburn Wastewater Treatment Plant Stream Study.

2. Fish Stocking Records

The following stocking records were found in CDFG's Region 2 files:

Species	Origin	Date	Size (No./lb)	Mean Length*	Number Stocked	Location
Brown trout	Mt. Shasta	6/25/30			10,000	Dutch Ravine tributary near Goldhill Road
Brown trout	Mt. Shasta	7/1/32			10,000	Dutch Ravine tributary near Goldhill Road
Rainbow trout	Mt. Shasta or possibly Bear River	1948				Note that stream was planted, but no planting receipt
Rainbow trout	Bear River	7/28/49	232	56	4,988	Could be near Wise Powerhouse or east
Rainbow trout	Bear River	1950	245	55	1,989	USGS Quad description not in Auburn Ravine Watershed
Rainbow trout	Mt. Shasta	7/19/51	224	56	2,602	Near Wise Powerhouse
Rainbow trout	Mt. Shasta	7/25/52	256	54	2,000	Near Wise Powerhouse
Rainbow trout	Mobile?	7/15/53	256	54	2,000	Near Lozanos Road
Rainbow trout catchables		5/10 to 7/4/59				Auburn – probably kids fishing program
Brown trout		5/10/89		229	500	Upstream of Marguarite Mine in Auburn – fish kill mitigation
Spring chinook salmon	Feather R. FH	2/20/85	344	54	77,400	Moore Road
Fall chinook salmon	Feather R. FH	1/31/86	480	48	24,000	Garden Bar Road
Fall chinook salmon	Feather R. FH	1/27/87	800	41	50,400	Highway 65
Fall chinook salmon	Nimbus FH	1/13/89	1,072	37	100,700	Goldhill Road.?

Fall chinook salmon	Nimbus FH	1/25/90	1,245	35	124,500	Goldhill Road
Fall chinook salmon	Feather R. FH	2/25/92	764	41	101,612	Goldhill Road
Fall chinook salmon	Feather R. FH	2/19/93	1,165	36	100,190	Goldhill Road
Fall chinook salmon	Nimbus FH	2/3/94	1,100	37	107,800	Goldhill Road
Fall chinook salmon	Nimbus FH	2/3/95	1,040	37	99,840	Goldhill Road
Fall chinook salmon	Nimbus FH	1/10/96	1,200	36	104,400	Goldhill Road
Fall chinook salmon	Nimbus FH	2/27/97	760	41	102,600	Goldhill Road

*Length estimates (mm) from Fish Hatchery Management, Fish and Wildlife Service, 1992.

3. Adult Spawning Timing, Distribution, and Population Estimates

- **1991 Memorandum entitled "Recollection of Auburn Ravine Creek, Coon Creek and Dutch Ravine Creek by Ancle "Slim" Goodall":** This memo documents the memories of Mr. Goodall regarding his fishing and species caught starting in 1939 or 1940. Mr. Goodall fished Auburn Ravine from the Wise Powerhouse downstream to Lincoln. He states it "… was a known fact that steelhead and salmon came up to the Wise Powerhouse back in those days." He personally caught 18" fish and (say) 20" fish were routinely caught in the early days. In the 1960's fishing really slowed down. **Source: May 26, 1991 Conversation documented by Ron Otto.**

- **1964 Fall-Run Chinook Salmon Spawning Survey by Eric Gerstung:** Gerstung conducted a survey of 500 ft. of stream at the Fowler Road Bridge (noted in the records as Silva-Bertholt Bridge in the original memo) on 11/23/64. He saw no carcasses and 15 live fish. He estimated the run size to be 300 fish and indicated, for streams in the area, that the run size was much greater in 1963, although no specific reference to any particular stream was noted. The information on the 1963 run size is not in the CDFG files reviewed. Water clarity was reported as muddy and flow estimated at 25 cfs. **Source: May 25, 1965 memorandum in CDFG, Region 2 files.**

- **December 6, 1985 Spawning Survey:** Auburn Ravine was surveyed for fall chinook salmon on 12/6/85. The stream was survey from approximately ½ mile upstream of Goldhill Road crossing to about ½ mile downstream of the same crossing. There had been a week of rain; visibility was estimated at 18", and flows at 40-50-cfs. A 4ft. waterfall was noted approximately ½ mile upstream of the road crossing. Twelve adult chinook salmon were observed actively spawning from the fall to about ½ mile downstream from the bridge. Most chinook salmon were about 28" but one 40" male was observed. Spot checks were made at Bridge Lane and Fowler Road with no fish observed. Run size was estimated as 100 fish. **Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.**

- **Fall 1986 Salmon Spawning Surveys in the City of Lincoln:** Fred Meyer conducted surveys on four sections of Auburn Ravine in November of 1986. The first survey was conducted on 11/3/86 in the City of Lincoln. Meyer saw 12 salmon. Flow was estimated at 10-12 cfs, but higher flows had occurred before the survey. A second survey of two stream segments was completed on 11/13/86. The first segment included walking for 25 minutes downstream from Highway 65. Fred reported 3 unmarked, live salmon; 3 obvious redds; and 4 carcasses. A local citizen reported seeing 40 fish. The second segment surveyed was from Highway 65 upstream to the Highway 193 Bridge crossing. Meyer recorded 7 dead; 1 live; and over 50 redds. He also reported broken spears and a line of eggs going up the bank. He estimated both age II and age III fish. The population at 200 fish with an additional 100-200 poached. His last survey occurred on 11/17/86 at the Goldhill Bridge with no fish observed. **Source: Fred Meyer memorandum in CDFG Region 2, files.**

- **1/2/92 John Hiscox Memorandum:** In this memorandum, Hiscox documents information regarding a fish sample he received from Ron Otto, in October 1991. Otto states that the fish was caught in early September 1991 and frozen before being given to Hiscox. Hiscox noted the following: fish was 16.2" long and weighed 1.45 lbs.; silver along the sides, no parr marks or striping; fish were intact with no feathering (hatchery origin fish often have deformed fins because of rubbing against the concrete raceway bottoms or walls). Scale analysis indicated that this fish was 2 years old, with widely space circuli and well defined annuli. Hiscox's conclusion is that fish was anadromous. **Source: 1/2/92 Memorandum from John Hiscox, District Fisheries Biologist, CDFG Region 2, files.**

- **11/30/94 Nelson Lane Observations:** Six salmon were sighted below the diversion dam just downstream of Nelson Lane near the Lincoln Airport. The dam was removed two days later and the author heard of salmon sightings further upstream, but was unable to confirm this information. **Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.**

4. Juvenile Distribution and Sampling Data

- **March 3, 1959 Electrofishing Sample:** A one-day electrofishing sample was collected from Auburn Ravine near the Goldhill Road Bridge on 3/3/59. A 350 ft. section was electrofished. Flow was reported as 10 cfs, channel width 15 ft., and pools 2-6 ft. deep. Good fishing was reported upstream of the Bridge. Species captured included: rainbow trout (few); brown trout; suckers; hitch; green sunfish (few). **Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.**

- **Spring 1965 Fall-Run Chinook Juvenile Emigration Survey by Eric Gerstung:** Gerstung began trapping downstream migrant fall-run chinook juveniles in Auburn Ravine just downstream of Fowler Road (noted in the files as Silva-Bertholdt Road) in mid-February 1965 and continued through mid-March (original data sheet missing from the files). Sampling was with a "riffle" trap or perforated plate trap. The trap fished a

total of 515 hours and captured 63 juvenile chinook salmon. No other fish species catch composition or specific data is reported. **Source: May 25, 1965 memorandum in CDFG, Region 2 files, handwritten draft of May 25, 1965 memo, and other handwritten notes.**

- **August 1971 One-time Seining Event:** The Department of Fish and Game conducted a one-time seining event on August 27, 1971 at an undefined location in Auburn Ravine. Although no location is given, the stream channel was recorded as being three feet wide, water depth 0.25 ft. deep, with commercial land use next to the stream. Given these conditions, this location was near the City of Auburn. A 50-foot section was electrofished. Catch composition is reported as: 3- rainbow trout (2.2", 3.2", 8.3") and 1- green sunfish (3.9"). **Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.**

- **March 1979 Electrofishing Survey:** The Department of Fish and Game conducted a one-time electrofishing survey at three locations on Auburn Ravine in and near the City of Auburn on 3/20/79. **Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.**

Location	Length Fished	Catch Composition
Auburn Ravine Rd. at Persimmon Ave.	130 yds.	12-rainbow trout (4-7"); 2- green sunfish ((7-8"); 8- roach (1-3")
Placer Terrace Apt. near freeway	100 yds.	10- rainbow trout (4-8" in excellent condition); 1- green sunfish (5"); 1- largemouth bass (2"); 8- roach
Ophir Rd. at Stonehouse Rd. below old sewer plant	100 yds.	No fish captured

Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.

- **1984 Seining and Electrofishing For Native Brood Year 1983 Fall-Run Chinook Salmon:** Water temperatures for this sampling effort are reported above. The following sampling results were reported: **Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.**

Date	Effort	No. chinook	Length Mode (mm)	Length Range (mm)	Other Fish Species	Location
2/28/84	2 seine hauls	1	--	41	1- sucker	Moore Rd.
2/28/84	2 seine hauls	0	--	--	8-suckers	Fowler Rd.
4/2/84	1 seine haul	7	47	43-68	4- rainbow trout; 11- squawfish*; 8- suckers	Fowler Rd.
5/2/84	1 seine haul	2	--	67, 68	11- rainbow trout	Fowler Rd.

5/24/84	1 seine haul	0	--	80, 81	1-sucker	Fowler Rd.

***** Sacramento squawfish are now known as Sacramento pikeminnow.
Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.

- **November 1984 Electrofishing Survey by Sacramento State University Professor Dave Vanicek at the Otto Residence:** Dr. Vanicek conducted an electrofishing survey of approximately 1,000 ft. of stream at the Otto Residence off Wise Road just downstream from the City of Auburn's wastewater treatment facility on 11/3/1984. Water quality and water temperature measurements are reported above. Fish species catch is reported: **Source: Copy of Vanicek's Report in CDFG, Region 2 files.**

Fish Species	N	Fork Length of Individuals (mm)
speckled dace	1	88
green sunfish	1	166
Sacramento sucker	5	138, 146, 148, 153, 202
rainbow trout	26	58, 75, 81, 88, 95, 96, 98, 99, 100, 101, 101, 102, 105, 106, 112, 115, 116, 118, 121, 122, 123, 127, 133, 134, 146, 262

Source: Copy of Vanicek's Report in CDFG, Region 2 files.

- **1985 Electrofishing Record from Dutch Ravine:** The Department of Fish and Game conducted a one-time electrofishing survey in Dutch Ravine at Dutch Court road crossing on 3/26/85. Water temperature was reported as 61 ^{O}F at 1500 hours. Stream is described as low gradient; some gravel; much sand; canopy heavy with berry, alders, and buckeye. A 100-foot section was sampled with one pass and had the following reported catch:

  squawfish – 2 young of the year and 2 – adults
  suckers – 4 young of the year and 4 adults
  one brown trout greater than 150 mm
  one rainbow trout less than 150 mm and 2- rainbow trout greater than 150 mm
  Source: Unsigned, unidentifiable author note in CDFG, Region 2 files.

- **1990 Michael Sarkisian Letter:** Mr. Sarkisian of Newcastle, wrote a letter to the Department of Fish and Game in which he claims to have seen approximately 1,000 salmonid fingerlings, which he believes to be steelhead, in isolated pools west of Lincoln. **Source: Letter from Mr. Sarkisian, received 6/16/1990, CDFG, Region 2 files.**

- **1993 Fish Kill Report: Source:** A fish kill occurred on October 26, 1993 as a result of a discharge from the City of Auburn's wastewater treatment plant near Auburn. All fish for approximately 1-2 miles downstream from the discharge location were apparently killed. Estimates of the number killed are based on electrofishing the next day, upstream from the discharge. Dead fish were reported as rainbow trout, sucker, squawfish, and hardhead. The official loss report estimates the losses as 6,400 rainbow trout from 1.5"-10" in length; 8,000 suckers from 4"- 18" in length; and 950 hardhead 3 inches in length. No estimates of squawfish losses are reported. Local citizens reported rescuing several 12"-16" rainbow trout, all of which later died. The length range of rainbow trout

indicates probably 4 age classes were present. **Source: October 26, 1993 Fish Kill Report, CDFG, Region 2 files.**

- **1995-1996 Monitoring Results from the 1996 City of Auburn, Draft Auburn Wastewater Treatment Plant Stream Study:** Attachment 3 of this document describes the results of electrofishing subsampling that occurred in six reaches of Auburn Ravine downstream from Interstate 80 to a point approximately 1,500 feet downstream from the Lozanos Road Bridge. Sampling was conducted in October 24-28, 1995 and again from April 4-9, 1996. Sampling results for steelhead/rainbow trout are presented in Attachment 3, Tables 8a and 8b, respectively. The October 1995 results indicate an extremely productive trout stream with 4 of 6 reaches having an estimated steelhead/rainbow trout biomass exceeding 125 lbs/linear mile of stream. April 1996 biomass estimates ranged from 14-62 lbs/linear mile but average fish size remained about the same, with only small increase in average length. I speculate that much of the biomass emigrated to downstream areas and/or to the ocean as steelhead smolts. This scenario would be consistent with a normal steelhead stream and appears to be supported by data presented in Figures 14 and 15 in Attachment 3. **Source: 1996 City of Auburn, Draft Auburn Wastewater Treatment Plant Stream Study.**

- **1999 DEIR City of Lincoln Wastewater Treatment and Reclamation Facility:** This DEIR (Appendix F, Table F-4) documents fish sampling conducted by Jones and Stokes Associates in November 1997 and Bailey Environmental/Dean Carrier and Associates in November 1998 (Appendix Table F-5). These sampling efforts document many of the species listed in the "Documented Fish Species Present in the Stream" section of this report. The major exception is that no chinook salmon were captured, but this would be expected because of the low water which prevented adult access in November 1997 or 1998 and juveniles would have left the stream the previous spring. Bailey Environmental sampling documented the presence of steelhead smolts (juveniles approximately 150 in length and having silvery sides with no parr marks). Approximately 50% of the juvenile steelhead captured had or were under going parr/smolt transformation. The remaining 50% had not yet started to turn color, but were on average about 25 mm shorter. These fish would be expected to smolt before spring and move to the ocean during spring flows. **Source: DEIR City of Lincoln Wastewater Treatment and Reclamation Facility, September 1999.**

- **Reports of "Half-Pounder" Steelhead in Auburn Ravine:** There is a growing body of anecdotal evidence to suggest that steelhead that exhibit this particular life history pattern enter Auburn Ravine in the spring and migrate to upstream areas. Half-pounders exhibit an unusual life history pattern in that they migrate as young adults (usually spending only one year in the ocean or estuary) into their natal streams in late spring and through the summer if stream conditions are right. A number of streams on the coast of California have half-pounder runs. Information that supports such a finding includes:

  (a) Conversations with Dr. Ron Otto, who lives in the Ophir area, who is a highly knowledgeable steelhead fisherman. Otto has continually caught steelhead in the15"-20" range near his home on Auburn Ravine during the summer and early fall time periods,

certainly before fall rains and removal of diversion dams would have permitted fish to migrate into the stream. He has documented lengths and has photos of fish that are obviously silvery in color and have not been in freshwater for any length of time.

(b) The conclusion of John Hiscox, Department of Fish and Game District Biologist that a fish caught in early September by Dr. Otto was anadromous in origin (see details above in this chapter).

(c) Statements on page 3-80 of the DEIR/DEIS City of Auburn Wastewater Treatment and Disposal Master Plan for the City of Auburn, prepared by Quad Consultants and Dewante and Stowell Consulting Engineers. This document indicates that half-pounders are known to utilize Auburn Ravine for spawning during the winter. No specific reference is cited. However, Dennis McEwan, Department of Fish and Game steelhead specialist (Department of Fish and Game Fish Bulletin 179 "Contribution to the biology of Central Valley Salmonids", Volume 1) states that no summer steelhead runs occur in the Central Valley. The behavior of these fish in Auburn Ravine, entering in late spring is atypical of normal winter migrating adults found in the rest of the Central Valley.

(d) Observations by Mark McClure, Lincoln resident, to Randy Bailey, Bailey Environmental. McClure said that on July 9, 2002 he had observed three steelhead (about 20" to 22"long) in a pool approximately 100 yards downstream from the Joiner Parkway Bridge in the City of Lincoln. Mr. McClure is a City of Roseville fireman and an avid fisherman. I have questioned him on several occasions regarding his general knowledge of fish and fish behavior. I find his account totally plausible based on his knowledge of the species and the water temperature data for that time period recorded at the NID gaging station located about 1 mile upstream from the subject location.

(e) Riley Swift, owner of Restoration Resources, reported to me that Tim Pafford, a fish biologist employed by Riley, had seen what he (Pafford) believed to be half-pounders jumping at the face of the South Sutter Diversion Dam on the Aitken Ranch in May 2003 or possibly 2002. This report is especially important because the timing of the installation of South Sutter's various diversion dams usually occurs in mid-April, after being down all winter when normal adult winter steelhead would be migrating.

(f) A 5/10/94 letter from the Department of Fish and Game (copy in Region 2 files) to Jim McKevitt (at that time head of the Central Valley Project Improvement Act Program for the U.S. Fish and Wildlife Service) regarding the needs for Auburn Ravine. One of the concerns expressed by the Department was the need to get steelhead upstream of NID's Auburn Ravine #1 Diversion Dam [I assume] on a consistent basis. Fish move over the dam (located upstream of Goldhill Road and consisting of an 11 ft. high concrete arch dam across the channel) on high flows. The Department suggests that a fish ladder is needed at this location (See a more detailed discussion of fish passage at this site below).

F. Fish Passage or Screening Data

1. Man-Made Structures or Pumping Stations. The following information is abstracted from the reconnaissance level survey of the various diversion dams located in Auburn Ravine, completed by James Buell, PhD and reported in detail in the April 2002Auburn Ravine/Coon Creek Ecosystem Restoration Plan in the watershed area of interest to this assessment. The reader should note, that none of the recommendations for action considered the presence and migratory timing of half-pounder steelhead migration in the spring or early summer. Since this concern has been more fully documented, Dr. Buell and I have discussed ways in which to provide upstream fish passage for half-pounders. Recommendations developed during these discussions are presented. These recommendations would provide implementable solutions to fish passage at relatively modest cost at most locations.

- **Nevada Irrigation District Gaging Station**

(a) **Location:** The site is located about 1/4 mi downstream of SR 65 in the City of Lincoln.

(b) **General Description**: This structure is a full channel width concrete section installed in association with a recording stream gage owned and maintained by Nevada Irrigation District. The section forms a broad flume with vertical sides, an upward-sloping approach, and a level crest with an ogee shape descending to a horizontal apron which spills onto large boulders to dissipate energy and prevent undermining. The flume and crest section is 25 ft wide, with flaring upstream and downstream sidewalls.

(c) Assessment: This structure is a significant impediment to upstream anadromous fish migration at all but extremely high flows, when the structure would become drowned out. Good passage requires either swim-up conditions (preferred) or the combination of a plunge pool with a standing wave, height of the obstruction less than the leaping ability of the fish, and quiescent "receiving water" conditions at the top of the obstruction into which the fish can leap. None of these conditions is met at this site under most stream flow conditions (when the structure is drowned out, swim-up conditions are likely present). Since this assessment was initiated, NID has performed maintenance at the downstream edge of this structure. A field of boulder riprap was placed below the downstream lip of the structure to prevent further erosion and undermining of the structure. This configuration is now probably a barrier to fish passage under low to moderate flows.

(d) **Priority for Attention:** High.

(e) **Alternative Approaches:**

Formal Fishway – This alternative would involve construction of a formal engineered fishway around the site. Recommended configuration for this alternative is a vertical slot and orifice fishway of standard design. Location should be on the right bank if

maintenance access across adjacent private land can be obtained (to reduce poaching and vandalism risks) or on the left bank if such access can not be obtained. If the structure is constructed on the left bank, which would be easily accessible to vandals and poachers (high risk at this site), the fishway should be completely covered with a heavy-duty locked grating. Maintenance during the migration season should be at least weekly, to keep the fishway clear of obstructing debris. If this alternative is implemented, the entire complex would have to be re-rated to calibrate the stream gage. Some minor loss of precision may result due to increased hydraulic complexity, especially if debris is allowed to accumulate in the fishway.

Pool-and-Chute Replacement – This alternative would involve the replacement of the existing concrete section with an engineered "Pool-and-Chute" fishway spanning the entire channel. These structures are essentially a series of shallow-angle "V" weirs with a central notch to the structure floor about 1 ft in width. Although relatively new in design, this structure is well tested, and provides good passage conditions for both adult and juvenile anadromous fishes under a very wide range of flow. The formal design of these structures is conducive to the development of rather precise stage-discharge relationships, making this alternative a suitable substitute for the existing section at this stream gaging site. Naturally, the gage would have to be re-rated, but the resulting precision would likely be as good or nearly as good as the existing flume section, and superior to the combination of the existing structure and a circumventing formal fishway.

Backwater Existing Section – This alternative would involve placing a series of low, very shallow angle "V" weirs across the channel downstream of the existing concrete section to backwater the existing section to the point where swim-over conditions were achieved for most stream discharges typical of the anadromous fish upstream migration season. Implementing this approach would seriously compromise the precision of the gaging station. More importantly, this approach would significantly reduce the conveyance capacity of the channel immediately downstream of the gage, resulting in increased flood risk. Although technically feasible with accompanying flood protection measures, this approach is probably not practical.

(f) **Recommendation:** The "Pool-and-Chute Replacement" alternative is recommended.

- **Davis Dam**

(a) **Location:** Davis Dam is located between the Pleasant Grove Road crossing and the Union Pacific Railroad tracks in Sutter County.

(b) **General Description:** Davis Dam is a seasonal flashboard dam in a highly modified reach of Auburn Ravine on the valley floor. The 12 ft wide rectangular concrete abutments are 40 ft apart, connected by a concrete slab on the channel invert. A major water turnout is located immediately upstream on the right bank, consisting of an unscreened 42 in diameter culvert with a knife gate, operated by a wheel. This dam is in operation annually from 15 April to 15 October.

(c) **Assessment:** The seasonal operation of this dam means that it is not a significant impediment to upstream-migrating anadromous fish in most if not all years. This facility is on the valley floor in an area where water temperatures are not conducive to year-round rearing of anadromous fish. In addition, most active downstream migration of smolts in most years is outside the irrigation diversion season. For these reasons, screening the turnout adjacent to Davis Dam, and other diversions (pumped or gravity) in this area should be considered a low priority action, if it is justified at all.

(d) **Priority for Attention:** Low.

(e) **Alternative Approaches:** None developed.

(f) **Recommendation:** No change.

- **Tom Glenn Dam**

(a) **Location:** Tom Glenn Dam is located on Auburn Ravine

(b) **General Description:** Tom Glenn Dam is a seasonal flashboard dam on a highly modified reach of Auburn Ravine on the valley floor. The trapezoidal abutments are 40 ft apart, connected by a rough, 8 ft broad ogee-shaped concrete sill with a downstream transition into a short "flip-lip". The "flip-lip" is broken away on the right side, but the structure does not appear to be at risk of undermining. Tom Glenn Dam is operated annually from 14 April through 15 October.

(c) **Assessment:** The seasonal operation of this facility means that it is not a significant impediment to upstream-migrating anadromous fish in most if not all years. In spite of the elevated sill, in its flashboards-out condition, this structure does not present a significant impediment to upstream anadromous fish migration, partially because of the broken condition of the "flip-lip" near the right abutment; if this were repaired, this structure would become a minor impediment at low flows, but at higher flows, typical of most upstream migration periods, a swim-over condition would be present. This facility is on the valley floor in an area where water temperatures are not conducive to year-round rearing of anadromous fish. In addition, most active downstream migration of smolts in most years is outside the irrigation diversion season.

(d) **Priority for Attention:** Low.

(e) **Alternative Approaches:** None developed.

(f) **Recommendation:** No change.

- **Aitken Ranch Dam**

  (a) **Location:** This dam is located on the Aitken Ranch, just west of Fiddyment Road.

  (b) **General Description:** Aitken Ranch Dam is a seasonal flashboard dam on a modified reach of Auburn Ravine on the valley floor. The trapezoidal abutments are 26 ft apart and are connected with a concrete sill even with the channel invert. The abutments support a flat car bridge. Aitken Ranch Dam is operated annually from 15 April through 15 October.

  (c) **Assessment:** The seasonal operation of Aitken Ranch Dam means that it is not a significant impediment to upstream-migrating anadromous fishes in most years. This modified (channelized) reach of Auburn Ravine has physical habitat features which could support rearing juvenile anadromous fish, and temperatures in this part of the valley floor during at least part of the irrigation season would also support populations of these fish in some years. Although no diversion is located in the immediate vicinity of this structure, those within its influence upstream are unscreened, and may be candidates for screening.

  (d) **Priority for Attention:** Low for dam; medium for unscreened diversions in this reach.

  (e) **Alternative Approaches:** None for upstream passage. Unscreened diversions under the influence of Aitken Ranch Dam were not directly observed, but simple rotating drum screens meeting anadromous fish screening criteria (3/32 in clear space screens sized to achieve < 0.4 fps approach velocity with internal porosity control) would likely be appropriate for pumped diversions. Gravity diversions, if any are present in this area, should be assessed for screening feasibility; vertical flat plate screens meeting the above criteria and with automatic wiper systems for cleaning would likely be the best approach if screens are deemed necessary.

  (f) **Recommendation:** Do nothing for upstream passage. Assess unscreened diversions and seasonal stream temperatures, perhaps in conjunction with fish surveys to establish juvenile anadromous fish presence during the irrigation season, to determine if screens are needed.

- **Moore Dam**

  (a) **Location:** Moore Dam is located on Auburn Ravine just upstream of Moore Road.

  (b) **General Description:** Moore Dam is a seasonal flashboard dam on a somewhat modified reach of Auburn Ravine on the valley floor. A relatively wide expanse of semi-natural channel and riparian corridor extends upstream of the dam structure. The rectangular abutments are 56 ft apart and are joined by a concrete slab on the channel invert. Moore Dam is operated annually from 15 April to 15 October. A major water turnout is located in an alcove off the main Auburn Ravine channel about 70 ft to the

right of the right abutment, and is controlled by twin knife gates on two 36 in diameter culverts passing under an access road to a canal.

(c) **Assessment:** The seasonal operation of Moore Dam means that it is not a significant impediment to upstream-migrating anadromous fishes in most years. This reach of Auburn Ravine has physical habitat features which could support rearing juvenile anadromous fish, and temperatures in this part of the valley floor during at least part of the irrigation season would also support populations of these fish in some years. The diversion located in the immediate vicinity of this structure is unscreened, and may be a candidate for screening, along with others in this general area. The appropriateness for screening should depend on future investigations and temperature data review to see if they indicate that there is a significant risk to rearing anadromous fish populations in the general vicinity during the irrigation season.

(d) **Priority:** Low for passage. Medium for unscreened diversions in this reach (pending results of temperature data review).

(e) **Alternative Approaches:** If screening is deemed appropriate, simple rotating drum screens meeting anadromous fish screening criteria (3/32 in clear space screens sized to achieve < 0.5 fps approach velocity with internal porosity control) would likely be appropriate for pumped diversions. Gravity diversions, such as the turnout in direct association with Moore Dam, should probably be fitted with vertical flat plate screens meeting the above criteria and with automatic wiper systems for cleaning would likely be the best approach. In this case, the screen should be placed diagonally across the alcove with the downstream end on the left (looking in the direction of water flow. At that point, a 6 in diameter bypass pipe should be buried under the ground separating the right dam abutment from the alcove, with the bypass terminus in the scour pool below the dam.

(f) **Recommendation:** No upstream passage improvements are needed. Assess unscreened diversions and seasonal stream temperatures, perhaps in conjunction with fish surveys to establish juvenile anadromous fish presence during the irrigation season, to determine if screens are needed.

- **Nelson Lane Dam**

(a) **Location:** Nelson Lane Dam is located on Auburn Ravine approximately ¼ mile downstream of Nelson Lane near the Lincoln Airport.

(b) **General Description:** Nelson Lane Dam is a seasonal flashboard dam on Auburn Ravine in the lower elevation foothills above the valley floor. The trapezoidal abutments are 60 ft apart and are joined by a declining concrete slab on the channel invert. Nelson Lane Dam is operated annually from 15 April to 15 October in most years. A major pumped water diversion is located at the end of a long alcove off the main Auburn Ravine channel about 120 ft to the right of the right abutment. Four operating unscreened pumps are present with 8-10 inch diameter pipes extending into the alcove pool.

(c) **Assessment:** The seasonal operation of Nelson Lane Dam means that it is not a significant impediment to upstream-migrating anadromous fishes except at lower stream flows which may characterize portions of the migration period in some years. The tipped slab between the abutments creates a high-velocity area (super-critical flow) at lower discharge. This forces the water to become significantly shallower at this point and could create a significant impediment if lower stream flows persist. The water temperatures in this part of the Auburn Ravine watershed could support populations of rearing salmonid juveniles for at least portions of the irrigation season, making these fish vulnerable to entrainment by unscreened pumps associated with this facility. The location of the pumps at the end of an alcove with significant channel length means that if fish are actively migrating, they may enter a dead-end channel with downstream cues, leading to potentially significant migration delay.

(d) **Priority for Attention:** For upstream passage, medium. For pump screening, medium (pending review of temperature data and risk analysis).

(e) **Alternative Approaches:**

Upstream Passage – Pending discharge frequency data review and needs analysis, rock-bolt 10 x 10 inch treated timbers across the tipped concrete apron immediately downstream or immediately upstream of the flashboard channel supports, leaving a 1.5 - 2 ft wide gap in the middle of the span. This will form an attraction jet and concentrate flow into a deeper pattern, enabling passage at lower discharges. Clear out some of the rock debris in the pool immediately downstream of the concrete sill, as necessary.

Pump Screens – Pending water temperature data review and risk assessment, install vertical, rotating drum screens on each of the four pumps. Install a treated lumber wing-wall across the alcove near the pumps, leaving a gap of 3-4 ft between the end of the wall and the right alcove bank. This will force water flowing toward the pumps to approach from the right side of the pump line and pass along the line toward the left alcove bank. Install a 6 in diameter bypass pipe leading from the left alcove bank through the ground separating the alcove from the main Auburn Ravine channel, terminating below the sloping concrete sill between the dam abutments. Excavate a pool at the end of the pipe and submerge the outlet to kill the jet. This arrangement will create a sweeping flow along the row of pumps toward the bypass pipe and provide a downstream migration cue guiding fish to the bypass. It will only be necessary to operate the bypass during the downstream migration period.

(f) **Recommendation:** Perform need (upstream passage) and risk (pump screening) analyses. If improvements are indicated by the analyses, implement the alternatives described above.

- **Lincoln Ranch Duck Club Dam**

(a) **Location:** Lincoln Ranch Duck Club Dam is located approximately one mile upstream of the Brewer Road crossing.

(b) **General Description:** Lincoln Ranch Duck Club Dam is a seasonal flashboard dam on a highly modified reach of Auburn Ravine on the valley floor. The rectangular abutments are 27 ft apart and connected by a concrete sill. The abutments are spanned by a flatcar bridge. A gravity water turnout is located on the right bank of Auburn Ravine immediately upstream of the right dam abutment. A pumped diversion fitted with a trash screen is set into the left bank of Auburn Ravine immediately upstream of the left dam abutment. Lincoln Ranch Duck Club Dam is unusual in that it is operated into late November (1998 data), well into the upstream migration season for adult salmonids. [Note: recent information indicates that this situation has been resolved, but the information is anecdotal and should be confirmed by discussions with the landowner and/or ranch manager.]

(c) **Assessment:** The unusual seasonal operation of this facility makes it a special case when assessing potential effects on upstream migration of anadromous fishes. The water surface elevation difference with flashboards in can be as much as 6 ft, depending on total stream flow. During higher flows, steelhead and chinook salmon can obviously negotiate this structure, since these species are known to reproduce at higher elevations in the watershed. However, this facility undoubtedly forms a significant impediment to upstream-migrating salmon and steelhead for a significant early part of the migration season. For this reason, passage improvements are desirable. The extended use of the associated pumped water diversion also poses some risk of entrainment of juvenile salmonids, especially small fry during initial dispersal following emergence from incubation. Although anadromous fish spawning is not thought to occur in the immediate vicinity of Lincoln Ranch Duck Club Dam, initial dispersal often transports fry considerable distances downstream. For this reason, screening this diversion, at least on a seasonal basis is considered desirable. A more complete evaluation, possibly incorporating sampling for fry presence during periods of operation, should be conducted prior to allocating significant expenditures for fish screens at this site, however.

(d) **Priority for Attention:** For upstream passage, medium to high, depending on water conditions during the upstream migration season. For diversion screening, low to medium, depending on a more thorough evaluation of seasonal entrainment risk.

(e) **Alternative Approaches:**

Upstream Fish Passage – This site is not well suited for a formal fishway bypassing the flashboard structure.

Pool excavation; pump extension -- This approach would involve excavating a pool or sump immediately upstream of the existing flashboard dam structure at the location of the diversion pump, and extending the pump tube into the sump. This would allow continued operation of the flashboards in the present manner, posing no change in upstream flood risk. The sump would have a tendency to accumulate fine sediment, however, potentially interfering with pump operation or increasing mechanical wear and maintenance costs. This might be successfully offset by installation of “vortex weirs” at the entrance to the

sump, which are designed to capture and concentrate bed load and "saltating" fine sediments and send them downstream. Some increase in energy costs would be incurred due to increased lift requirements.

Pool and chute fishway -- This approach would involve replacement of the existing flashboard dam structure with a formal "pool-and-chute" fishway section across the entire Auburn Ravine channel. This structure would permanently raise the invert elevation of the Auburn Ravine channel at this point, increasing the risk of flooding upstream in the event of very high discharge (no flashboard adjustment would be possible). The pool behind the structure would have a tendency to fill with fine sediment, potentially interfering with pump operation or increasing mechanical wear and maintenance costs. No increased energy cost would be incurred, however.

Screening – Pending an entrainment risk analysis demonstrating need, the diversion pump could be fitted with a vertical drum screen meeting appropriate fish screen criteria (3/32 in clear space screens sized to achieve 0.4 fps approach velocity with internal porosity control). A hydraulic analysis of the expected flow net in the immediate vicinity of the screen should be performed to determine whether a simple rotating screen or a back-flush or wiper system would be most appropriate for screen cleaning.

(f) **Recommendation:** For upstream-migrating anadromous fish passage, implement the first alternative described above. Analyze the appropriateness of use of "vortex weirs" and develop a maintenance schedule accordingly. Perform an entrainment risk analysis, and install a drum screen if indicated by the analysis.

- **NID Diversion (Hemphill Dam)**

(a) **Location:** Hemphill Dam is located on Auburn Ravine upstream of the City of Lincoln, adjacent to the Turkey Creek Golf Course.

(b) **General Description:** Hemphill Dam is a relatively large seasonal flashboard dam on a slightly modified reach of Auburn Ravine in the low elevation foothills of the watershed near the Turkey Creek Golf Course. The trapezoidal dam abutments are about 8 ft high and 64 ft apart, connected by an elevated horizontal concrete sill. A relatively smooth gunnited rubble apron slopes downstream from the concrete sill to a plunge pool filled with large angular boulders for energy dissipation. Banks upstream and downstream of the abutments are about 75 ft apart and are protected by large gunnited rip-rap. This bank protection is more prominent on the right bank, extending about 75 ft upstream and 60 ft downstream of the abutments. An unscreened gravity diversion with a knife gate control and a sloping trash rack is located on the left bank about 50 ft upstream of the left dam abutment. The elevation of the sill between the dam abutments is about 6 ft above the natural invert of the stream channel, and the relatively smooth gunnited rubble apron produces very shallow super-critical sheeting flow at low to moderate stream flows.

(c) **Assessment:** At most stream flows, including flows representative of those occurring during the adult anadromous fish migration season, the configuration of the sill and apron at Hemphill Dam produces super-critical flow for a distance of at least 30 ft. This results in a velocity barrier condition for upstream-migrating anadromous fish at all but very high stream flows when the entire structure becomes drowned out and swim-over conditions would be present. The relatively greater bed roughness on the apron near the right abutment may ameliorate this condition somewhat, reducing passage difficulties at moderately high stream flows, but this structure would still probably be considered an impediment, potentially resulting in migration delays or "encouraging" fish to spawn further downstream than would otherwise be the case. It should be noted that there is some very good spawning habitat for chinook salmon, and possibly steelhead, in the reach downstream of Hemphill Dam. The gravity diversion is unscreened, and would present a threat of entrainment of juvenile salmonids present during periods of operation. Since this facility is in the low elevation foothills of the Auburn Ravine foothills, water temperatures would likely support rearing populations of juvenile salmonids during part of the irrigation season. In addition, as noted above, relatively good spawning habitat is present in the general vicinity of Hemphill Dam, suggesting that populations of rearing anadromous fish may well be present during portions of the irrigation season in at least some years. This suggests that screening the diversion in association with Hemphill Dam, and others in the general vicinity is appropriate.

(d) **Priority for Attention:** For upstream anadromous fish passage, high. For diversion screening, medium to high, depending on results of a risk assessment (perhaps including sampling for rearing anadromous fish presence during portions of the irrigation season).

(e) **Alternative Approaches:**

Upstream Fish Passage – Upstream fish passage at this site could be provided in two ways.

Pool and chute fishway -- This site is very conducive to installation of a pool and chute fishway spanning the entire Auburn Ravine channel. This structure would replace the existing gunnited rubble apron immediately downstream of the horizontal concrete sill connecting the dam abutments. Little or no change in channel conveyance capacity is anticipated for this approach. If detailed hydraulic analysis indicates that channel conveyance capacity would be reduced, it is expected that this change would be minor and could be mitigated by a slight increase in channel width at the dam site, which could be accomplished by moving one of the abutments back an appropriate distance. This approach would assure good passage conditions at all migration season discharges when the dam is in its flashboards-out condition. Advantages of this approach include essentially maintenance-free operation, good to excellent passage conditions under all or nearly all flow conditions, no migration delay and limited or no poaching/vandalism opportunities. Disadvantages include potential for slight decrease channel conveyance capacity and possibly relative cost.

Backwater the apron and add roughness -- This approach is similar to the pool and chute fishway described in the first alternative, above, but less formal in execution, with a less reliable outcome. Backwatering of the Hemphill Dam apron would involve construction of a series (probably three) of low, shallow "V" weirs, with each consecutive "V" 12-18 in higher in elevation than the one downstream. The furthest upstream "V" should be located near the toe of the existing apron. Roughness elements ("dentates") should be added to the apron near the crest to break up sheeting flow and provide hydraulic complexity. Advantages of this approach include good passage conditions over a wide range of stream flows while the dam is in the flashboards-out configuration, essentially maintenance-free operation, no significant migration delay, limited poaching/vandalism opportunities, and potential cost savings over the first alternative. Disadvantages include a larger construction footprint than the first alternative and a slightly increased potential for reducing overall channel conveyance capacity at the crest of the apron in the flashboards-out configuration. This last disadvantage could be overcome by moving one of the abutments back an appropriate distance, if deemed necessary.

Formal slotted fishway -- This approach would involve design and construction of a formal fishway around Hemphill Dam. Adequate space exists on either side of the dam, but each side has advantages and disadvantages. Advantages of the right side include lower poaching and vandalism opportunities. Disadvantages of the right side include more difficult construction and maintenance access, probably involving right-of-way acquisition. Advantages of the left side include easy construction and maintenance access and probably little or no difficulty obtaining a right of way or easement. Disadvantages include increased poaching and vandalism risk and an alignment conflict with the existing diversion canal, requiring an inverted siphon in the canal under the fishway alignment. Other advantages of this general approach include potentially lower cost and no risk of reduction of channel conveyance capacity. Other disadvantages of this general approach include a narrower range of ideal operating conditions relative to Auburn Ravine stream flow, increased overall risk of vandalism and poaching, and regular maintenance requirements.

Screening – If screening the gravity diversion is warranted by an entrainment risk analysis, the most appropriate approach for this site is a vertical flat plate screen meeting appropriate anadromous fish screening criteria (3/32 in clear space screen; 0.4 fps approach velocity) constructed flush with the left bank in the approximate location of the existing diversion. The screen should have a mechanical wiper for cleaning which could be driven mechanically or by hydraulic motor off a paddle wheel in the diversion canal. If water depth is insufficient to achieve necessary screen area without excessive length, the screen panel could be sloped, but the slope should not be flatter than 45 off the vertical with a mechanical wiper cleaning device. If the screen is flatter than 45 , an air burst cleaning system should be considered, but this would require pulling power to the site and installing a compressor and pressure accumulator tank, along with appropriate controls and sensors. The mechanical wiper system is by far the simpler system, and would require less maintenance and a lower capital outlay.

(f) **Recommendations:** For adult fish passage, implement the pool-and-chute fishway alternative on a high-priority basis, pending results of a uniform engineering cost estimate (if such a cost estimate favors the backwatering/roughness approach, implement that alternative instead). For screening, assuming an entrainment risk assessment indicates the need for screens, implement the described approach.

- **Ophir Tunnel Cataract**

(a) **Location:** The cataract at Ophir Tunnel is located just upstream of Lozanos Road on Auburn Ravine

(b) **General Description:** A steep cataract is located on Auburn Ravine immediately adjacent to the outlet of Ophir Tunnel. The flows over the cataract exhibit much hydraulic complexity passing over a very rough bed, except at the lower end, where the rock is smoother.

(c) **Assessment:** This cataract is clearly an impediment to steelhead at lower stream flows, but is probably passable to some fish at high stream flows. Because of the smoother bed and reduced hydraulic complexity at the lower end, this part of the cataract is the more difficult part for fish to negotiate. Some improvement in passage conditions over a wider range of flows could be achieved by backwatering the lower end of this cataract, giving fish an opportunity to reach more complex portions of this area with less effort and fewer trials.

(d) **Priority for Attention:** Medium.

(e) **Alternative Approaches:** The most cost effective approach to improving steelhead passage conditions at this impediment is to backwater the lower end of the cataract with a series of two or three low, shallow "V" weirs installed across the plunge pool immediately downstream. Crest elevations of these weirs should be 12 to 18 in apart; the weirs themselves should be about 10 ft apart, with the most upstream in the series about 10-12 ft downstream of the existing toe of the cataract.

(f) **Recommendation:** Implement the approach described above on a medium priority basis.

- **Nevada Irrigation District Auburn Ravine 1 Dam**

(a) **Location:** Nevada Irrigation District (NID) 1 Dam is located on Auburn Ravine off Chili Hill Road.

(b) **General Description:** NID 1 Dam is a gravity arch dam in the middle of the Auburn Ravine watershed. The level crest of the dam is about 8 ft above the tailwater during normal stream flows. The pool behind the dam feeds an unscreened gravity diversion to the NID ditch on the north side of Auburn Ravine. The ditch is lined with gunnite for most of its length in this area. A sluice gate for flushing sediment, which

accumulates behind the dam, is located on the north side of the crest near the entry to the ditch. Channel depth below the dam is deeper on the south side, with boulders and bedrock protruding from the tailwater on the north side during normal stream flows.

(c) **Assessment:** This dam is clearly a migration barrier to upstream-migrating salmon and steelhead except at high stream flows approaching drown-out, when it would become an impediment. The level crest distributes overflow evenly. Greater channel depth on the south side of the channel opposite the ditch would tend to encourage fish to congregate in that area under most flow conditions, making an accessible solution more difficult. A formal fishway on the south side of the dam is probably not feasible, due to severe access difficulties. Protruding bedrock formations on the north side of the channel below the dam add difficulty to a passage solution in that area. Presence and operation of the sediment sluice next to the ditch add complexity to a passage solution on the north side of the dam. Much of the best steelhead habitat in the Auburn Ravine watershed is located upstream of this facility, increasing the importance of a passage solution here. This part of the Auburn Ravine watershed contains excellent anadromous fish rearing habitat and water quality. Since juvenile anadromous fish are present in this area on a year-round basis, screening the approximately 100 cfs diversion is important.

(d) **Priority for Attention:** For upstream passage: high; for diversion screening: high.

(e) **Alternative Approaches:** Any passage solution on the south side of NID 1 Dam is plagued with virtually impossible access problems, effectively eliminating this area from consideration. Stepping up the stream channel below the dam would severely reduce channel conveyance capacity immediately below the dam, threatening the ditch and control works during high stream flows, effectively eliminating this approach as a viable solution candidate. The only remaining approach is to construct a formal fishway on the north side of the dam, in association with the canal, in spite of the presence and operation of the sediment sluice system in this area and protruding bedrock on this side of the channel immediately downstream of the dam. An integrated adult fishway and screen/bypass system is probably feasible. This approach would involve removing some of the bedrock outcrop on the north side of the channel (without threatening ditch or dam integrity) and constructing a slotted fishway structure on the south side of the existing ditch, possibly using remaining bedrock as foundation. The entry (downstream end) of the fishway should have multiple entry ports to provide entry “choices” under a variety of hydraulic conditions. Supplemental attraction flow in the form of a jet angled obliquely across the deeper water channel on the south side of the channel may improve fishway performance, and should be considered. The exit (upstream end) of the fishway should be into the existing canal. It should be located far enough downstream to serve as the juvenile bypass for a diagonal vertical flat plate screen meeting anadromous fish screen criteria (3/23 in clear space screen; 0.4 fps approach velocity). Assuming 4 ft submergence, gross screen area requirements for an assumed 100 cfs ditch capacity and some room for civil works and screen cleaning system mechanical systems; the fish screen structure would probably occupy 70-75 ft of channel length. Since the fishway slope would probably be about 1:10 - 1:15, this location could allow sufficient distance to

achieve necessary elevation gain. The screen wiper system for cleaning could be activated by pulling power to the site or by using a paddle wheel in the canal. Head loss associated with this system could probably be held to about 6 in if the screen is kept relatively clean. Under normal operating conditions, judging from water stains along the canal sufficient head is available. Some freeboard on the outer ditch wall may be necessary in the immediate vicinity of the screen system. It is possible that adult anadromous fish will have difficulty finding the fishway entry under some stream flows even with a supplemental attraction flow jet. If this proves to be the case, thought should be given to adding a very gradually sloping crest to the arch dam, with the crest about 4-6 in higher on the south side. This will gradually concentrate overflow moving along the crest, tending to pull fish to the north side of the channel, in spite of greater channel depth on the south side. This feature should only be added if deemed necessary through performance monitoring.

(f) **Recommendation:** Implement the described approach on a high priority basis.

2. Water Flows

Fall and winter water flows are particularly important in Auburn Ravine. Because water deliveries are curtailed, generally before fall-run chinook salmon attempt to migrate upstream to spawn, the depth of water in the channel can be insufficient to provide adult passage. Adult chinook salmon and steelhead need approximately 1+ foot of water depth with some resting pools in order to migrate upstream. Transit time for adult fish from the Cross Canal confluence to upstream of Highway 65 could routinely be accomplished in one to two days. However, adequate water depth is critical and should be taken into consideration concurrently with any fish passage projects for this drainage. Until water temperatures became too warm to allow safe entry into Auburn Ravine, flows downstream of diversion dams in the spring would be needed to pass half-pounder steelhead and allow migration into upstream areas. Another potential problem that has not been adequately addressed is the attraction of adult salmonids to the new discharge location of the new Lincoln wastewater treatment facility. While fish may be prevented from entering the discharge, the volume of water potentially discharged will be enough to provide routine fall/early winter passage for adult salmonids. However, once adult fish reach the location of the discharge, they potentially face a stream channel with little or no flow for miles. The area in which the discharge is located is not suitable for anadromous fish spawning.

3. Beaver Dams

Beaver dams and beaver activity in general are a major impediment to adult anadromous fish passage in this watershed. During the stream videography project, five major beaver dams were documented between the confluence with Eastside Canal and the Goldhill Road crossing on March 12, 2003. In addition two major beaver dams were located in the City of Lincoln approximately ½ mile downstream of Highway 65 and within the NID gaging station about a ¼ mile downstream of Highway 65. The dam in the NID gage was 4 feet tall and combined with the 4 foot drop at the downstream end of the structure, with no jumping pool, this situation was a barrier throughout the winter of 2002-2003.

APPENDIX AUBURN RAVINE 1

HEAVY METALS COMPARISON
BETWEEN AUBURN RAVINE AND EASTSIDE CANAL

	Assumes a Hardness of 50 mg/l as CaCO3	Maximum Concentration (Acute)	Continuous Concentration (Chronic)			
	METAL	(mg/l)	(mg/l)			
	Barium	No standard	No standard			
	Cadmium	0.002	0.0013			
	Copper	0.007	0.005			
	Zinc	0.067	0.066			

Stream	Location	Date	Cadmium mg/l	Copper mg/l*	Zinc mg/l	Notes
Auburn Ravine	Sutter County	01/25/01	0.000020	0.00381	0.00436	Hardness = 55 mg/l
Auburn Ravine	Sutter County	03/01/01	0.000024	**0.00571**	0.00482	Hardness = 70 mg/l
Auburn Ravine	Sutter County	04/05/01	0.000009	0.00201	0.00249	Hardness = 36 mg/l
Auburn Ravine	Sutter County	05/03/01	0.000006	0.00179	0.00111	Hardness = 36 mg/l
Auburn Ravine	Sutter County	06/06/01	0.000008	0.00247	0.00113	Hardness = 27 mg/l
Auburn Ravine	Sutter County	07/17/01	0.000018	0.00297	0.00388	Hardness = 27 mg/l
Auburn Ravine	Sutter County	08/02/01	0.000008	0.00177	0.00151	Hardness = 29 mg/l
Auburn Ravine	Sutter County	09/06/01	0.000006	0.00188	0.00088	Hardness = 25 mg/l
Auburn Ravine	Sutter County	10/11/01	0.000010	0.00293	0.00200	Hardness = 43 mg/l
Auburn Ravine	Sutter County	10/31/01	0.000038	**0.00525**	0.00624	Hardness = 59 mg/l
Auburn Ravine	Sutter County	12/21/01	0.000146	**0.01970**	0.02900	Hardness = 46 mg/l
Cross Canal	Sutter County	01/25/01	0.000039	0.00445	0.00555	Hardness = 65 mg/l
Cross Canal	Sutter County	03/01/01	0.000052	**0.01100**	0.0102	Hardness = 72 mg/l
Cross Canal	Sutter County	04/05/01	0.000014	0.00299	0.00301	Hardness = 46 mg/l
Cross Canal	Sutter County	05/03/01	0.000015	0.00298	0.0019	Hardness = 46 mg/l
Cross Canal	Sutter County	06/06/01	0.000023	0.00214	0.00113	Hardness = 52 mg/l
Cross Canal	Sutter County	07/17/01	No Flow	No Flow	No Flow	No Flow
Cross Canal	Sutter County	08/02/01	0.000015	0.00278	0.00291	Hardness = 59 mg/l
Cross Canal	Sutter County	09/06/01	0.000014	0.00302	0.0026	Hardness = 70 mg/l
Cross Canal	Sutter County	10/11/01	0.000013	0.00343	0.00236	Hardness = 65 mg/l
Cross Canal	Sutter County	10/31/01	0.000015	0.00354	0.00228	Hardness = 63 mg/l

Cross Canal	Sutter County	12/21/01	0.000098	**0.0117**	0.0158	Hardness = 58 mg/l

* Values in bold exceed California Toxics Rule objectives for aquatic life at a hardness of 50 mg/l.

Sources: California Toxics Rule (water quality objectives); Department of Water Resources unpublished data.

APPENDIX AUBURN RAVINE 2

Auburn Ravine Selected Water Quality Monitoring Data
Near the City of Auburn's Wastewater Treatment Plant
1995 Monitoring Results

1995 Monitoring Results for Selected Parameters from Auburn Ravine. Location R-1 is just upstream of the City of Auburn's Wastewater Treatment Plant Discharge. Location R-4 is Downstream of the Discharge in the Mixing Zone.

Parameter	Location	Frequency	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dissolved Oxygen	R-1	Mean Monthly	mg/l	11.1	12.1	9.8	11.3	11.1	11.4	10.9	10.6	9.8	10	10.7	11.7
	R-4	Single Sample	mg/l	11.09				10.5				9.78	9.25		
Temperature	R-1	Mean Monthly	^{O}C	8.7	6.4	7.5	9	9.8	11	12.3	14.3	15.9	14.56	11.9	10.1
	R-4	Single Sample	^{O}C	8.6				13				17.9	18.3		
pH	R-1	Mean Monthly	units	7.4	7.2	5.7	7.3	7.3	7.2	7	7.1	7	7.4	7.2	7.3
	R-4	Single Sample	units	9.4				6.6				7.14	7.73		
Nitrate	R-1	Mean Monthly	mg/l	2				<0.50				<0.50	3.6		
	R-4	Single Sample	mg/l	3				<0.50				1.8	3.7		
Total Phosphorus	R-1	Mean Monthly	mg/l	<0.05				<0.02				<0.02	0.04		
	R-4	Single Sample	mg/l	0.08				0.09				0.19	0.51		
Hardness	R-1	Mean Monthly	mg/l	36				23				20	61		
	R-4	Single Sample	mg/l	43				24				14	71		

Source: FEIR for the Auburn Wastewater Facility Plan, 1997; Adapted from Table 3-9.

APPENDIX AUBURN RAVINE 3

BENTHIC MACROINVERTEBRATE DATA
COLLECTED BY THE AUBURN RAVINE CITIZENS GROUP

PHYLUM																	
	Class																
		Order				Mar-00				Mar-00			Sep-01		
			Family			Auburn Ravine @				Auburn Ravine @			Auburn Ravine @		
			Genus species	TV[1]	FFG[2]	Joiner Parkway				Moore Road			Joiner Parkway		
ARTHROPODA															
	Hexapoda														
		Coleoptera (Larvae)													
			Elmidae	5	cg										
			Psephenidae	4	sc										
		Diptera													
			Chironomidae	6	cg	33	2	85	3	54	17	3	19	37	36
			Empididae	6	p			3							
			Simuliidae	6	cf								20		3
			Tipulidae	3	sh										
		Ephemeroptera													
			Baetidae	4	cg			6		7	4	3	19	18	40
			Ephemerellidae	1	cg						2	1			
			Leptohyphidae	4	cg			1					3	5	4
		Plecoptera													
			Capniidae	1	sh										
			Chloroperlidae	1	p	2	2	4	2	7	20	22	1	4	
			Perlodidae	2	p					1	8				
		Trichoptera													
			Brachycentridae	1	ot										
			Glossosomatidae	0	sc	1								1	
			Hydropsychidae	4	cf					1	1	1	1		
			Hydroptilidae	4	ot										
			Leptoceridae	4	ot									4	
			Philopotamidae	3	cf								1		
		Lepidostoma													
			Pyralidae	5	sc									1	
		Odonata													
			Coenagrionidae	9	p										
			Gomphidae	4	p								2	1	
			Libellulidae	9	p	1							2		1
Subphylum Chelicerata															
	Arachnoidea														
		Hydracarina (=Acari)		5	p			1		1	2	1	2	4	5
Subphylum Crustacea															
	Malacostraca														
		Amphipoda		4	cg									1	2
MOLLUSCA															
	Gastropoda														

		Limnophila												
		Planorbidae	6	sc									1	
	Bivalvia													
		Pelecypoda												
		Corbiculacea	10	cf								1		
NEMATODA			5	p										
NEMERTEA														
PLATYHELMINTHES														
	Turbellaria													
		Tricladida												
		Planariidae	4	p										
ANNELIDA														
	Oligochaeta		5	cg					1		2	11	5	5
		Total Macroinvertebrates:			37	4	100	5	72	54	33	82	82	96
[1] TV: Tolerance Values														
[2] FFG: Functional Feeding Groups														
		Taxonomic Richness			4	2	6	2	7	7	7	12	12	8
		EPT Taxa			2	1	3	1	4	5	4	5	5	2
		Ephemeroptera Taxa			0	0	2	0	1	2	2	2	2	2
		Plecoptera Taxa			1	1	1	1	2	2	1	1	1	0
		Trichoptera Taxa			1	0	0	0	1	1	1	2	2	0
		EPT Index			8	50	11	40	22	65	82	30	39	46
		Sensitive EPT Index			8	50	4	40	11	56	70	2	6	0
		Tolerance Value			5.6	3.5	5.7	4.0	5.2	3.1	2.2	5.3	4.9	5.0
		Percent Intolerant Organisms			8	50	4	40	11	56	70	2	6	0
		Percent Tolerant Organisms			2.7	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	1.0
		Percent Dominant Taxon			89	50	85	60	75	37	67	24	45	42
		Percent Collectors			89	50	92	60	86	43	27	63	80	91
		Percent Filterers			0	0	0	0	1	2	3	28	0	3
		Percent Grazers			3	0	0	0	0	0	0	0	4	0
		Percent Predators			8	50	8	40	13	56	70	9	11	6
		Percent Shredders			0	0	0	0	0	0	0	0	0	0
		Other			0	0	0	0	0	0	0	0	5	0
				03/01/00			03/01/00			09/01/01				
				Auburn Ravine			Auburn Ravine @			Auburn Ravine @				

	@ Joiner Parkway *			Moore Road			Joiner Parkway		
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	4	1.0	8	7	0.0	8	11	1.3	17
EPT Taxa	2	0.5	4	4	0.3	5	4	1.0	7
Ephemeroptera Taxa	1	0.5	2	2	0.3	2	2	0.0	2
Plecoptera Taxa	1	0.0	1	2	0.3	2	1	0.3	1
Trichoptera Taxa	0	0.3	1	1	0.0	1	1	0.7	4
EPT Index (%)	27	10	12	56	18	49	38	4.4	39
Sensitive EPT Index (%)	26	11	8	45	18	38	3	1.8	3
Dominant Taxon (%)	71	9.5	84	60	12	47	37	6.4	35
Tolerance Value	4.7	0.6	5.5	3.5	0.9	3.9	5.0	0.1	5.0
Intolerant Organisms (%)	26	11	8	45	18	38	3	1.8	3
Tolerant Organisms (%)	0.7	0.7	0.7	0.0	0.0	0.0	1.6	1.1	1.5
Collectors (%)	73	10	89	52	18	59	78	7.9	79
Filterers (%)	0	0.0	0	2	0.5	2	10	8.9	10
Grazers (%)	1	0.7	1	0	0.0	0	1	1.2	1
Predators (%)	27	11	10	46	17	39	9	1.4	8
Shredders (%)	0	0.0	0	0	0.0	0	0	0.0	0
Other (%)	0	0.0	0	0	0.0	0	2	1.6	2

* Site statistics based on small and variable sample sizes